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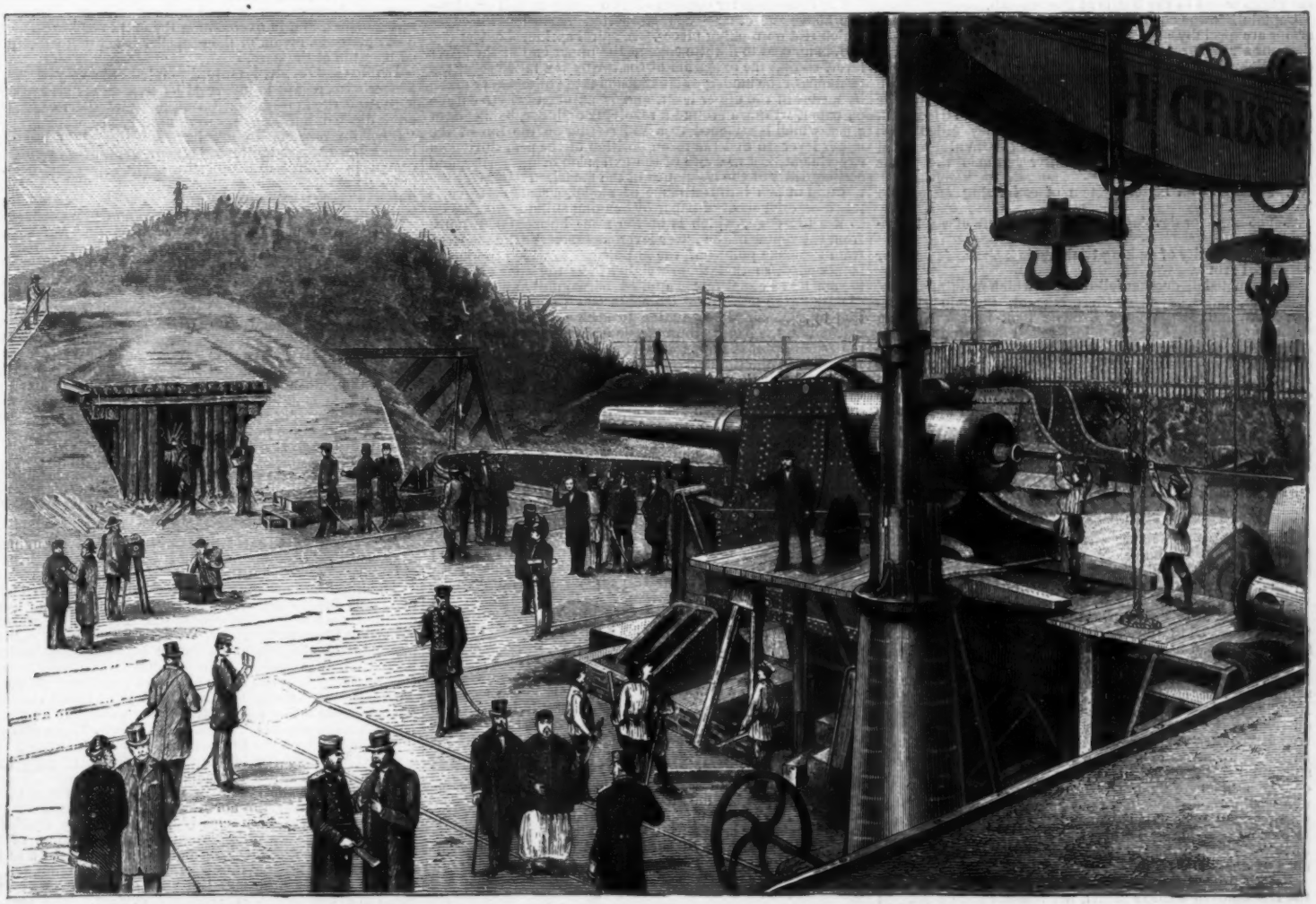
TRIALS OF ARMOR PLATES.

GRUSON'S improved chilled armor plates are used especially for revolving fortress towers and armored batteries such as are used in protecting coasts. They are not applicable to vessels, as their weight is too great. Gruson's armor plates are made of cast iron mixed in a peculiar manner and cast in iron moulds, whereby the armor plates obtain a chilled surface about one-third of an inch in thickness and as hard as steel. The chilled surface is connected by numerous microscopically fine arms or branches with the cast iron back. The cast armor plates which are used for building revolving towers or batteries weigh from about 10,000 to 16,000 pounds each.

The effect of a projectile on a chilled iron plate is entirely different from the effect of a projectile on the wrought iron plates used as armor for vessels. If a projectile of sufficient weight and sufficient force strikes one of the last named plates, the projectile enters the plate without changing its form, but perforates the plate or is forced through the plate and wounds or kills the men who have sought protection behind the armor. If every projectile fired catch the splinters and pieces of the projectile. In the wall facing the gun, an opening about two feet wide is made, through which the projectile passes to the armor plate, and on the latter a white cross is made to mark the point at which the projectile is to strike the plate. The cannon is placed about 90 feet from the target, a bell is sounded to indicate that all is ready, Gruson's artillerymen man the gun, sentinels and guards are sent out to prevent people from coming in dangerous proximity to the grounds, visitors and examiners retire into a suitable pavilion, and then the cannon is fired. The earthworks around the target are then cleared of the splinters and pieces of wood, iron, and steel, the effect of the projectile on the plate is carefully noted, even to the smallest details, and then the examiners and visitors retire, to return in about an hour for a second trial, as about one hour's time is required to set up an armor plate as a target.

THE ARMAMENT QUESTION.

A LECTURE on this subject was delivered at the Royal Service Institution lately, by Captain C. O. Browne, R.A.;



TESTING OF CHILLED IRON ARMOR PLATES.

at a vessel should strike it, it would be useless to armor vessels, as they would be perforated like a sieve in a short time, notwithstanding the armor. The chilled plate is totally different. The chilled layer has enormous hardness, and being based on a strong cast iron body about three feet thick, with which it is intimately connected, it can prevent all known projectiles from passing into the plate. The plate receives an enormous shock, and its surface is cracked in all directions; but, nevertheless, the projectile is not forced into the plate, but on the contrary is broken into numerous pieces from the size of a pea to the size of a fist, and the heat produced is so great as to give the steel of which the projectile is made all the different colors obtained in tempering. However, if several projectiles strike one plate successively, it first cracks into one or two parts, and under the effect of successive shots drops to pieces.

Mr. Gruson has constructed a shooting ground for the purpose of testing each class of plates. This shooting ground is shown in the annexed cut, taken from *Ueber Land und Meer*, which represents the handling of a 12 in. Krupp ring cannon. The enormous crane serves for lifting the cannon upon its carriage. The armor plate which serves as the target is united with several other plates which hold it more rigidly, and is partly surrounded by earthworks which

this officer occupies the position of lecturer on armor plates at Woolwich, and he may therefore be looked upon as an authority on the subject.

The lecturer commenced by stating that his chief object was to call attention to features in the position of the armor question that were peculiar and of importance. He then proceeded to give the data on which he based his arguments, and which were the results of experiments carried out at Meppen in March, 1882; at Spezia at the end of 1882; at St. Petersburg at the beginning of 1883; and at Shoeburyness in August and September, 1883.

We can summarize these trials as follows:

At Meppen the trials were of perforation of soft armor.* A 110 lb. shot, with a velocity of 1,749 ft., and striking energy of 2,330 foot tons, went through a target of two 7 in. wrought iron plates, with 10 in. of wood between them, and passed on over 800 yards, uninjured. This projectile would probably have penetrated 11¼ in. of wrought iron, and the extra 3 in. accomplished here, is due to the two plates being so far separated. The same gun fired at 35 deg. to the normal, against an 8 in. plate, with 10 in. backing of wood, penetrated. There were also trials made of large bursting charges, and stronger envelopes for common shell.

* By soft armor is meant that which yields to perforation. By hard armor that which cannot be perforated, but is destroyed by breaking up.

At Spezia the trials were of hard armor steel-faced plates, 19 in. thick, from Cammell & Co. and Sir John Brown & Co., and steel plates from Creusot. The 100 ton gun was used, and the result of two rounds on each target was decidedly in favor of the Schneider steel.

The St. Petersburg trials were carried out between Cammell's steel-faced armor and Schneider steel plates, 12 in. thick, an 11 in. gun being used. The result of three rounds was that the latter plate fell to pieces, while the former target had by far the best of it.

The experiments carried out by our engineers were to ascertain the protection afforded to granite walls by iron plates. The 80 ton gun was used, the targets being of 2·8 in. iron plates with 5 inches of wood between them, and 12 in. Wilson's steel-faced iron.

The battering projectile from the 80 ton gun passed clean through the plate and 10 ft. into the masonry beyond. Another round being fired at the 12 in. plates broke up in the iron. This projectile was supposed to be capable of penetrating 25 in. of iron. The fact of a 12 in. plate being able to keep it out must, the lecturer considered, be attributed to the hard granite backing.

Captain Browne then went on to discuss our system of calculating effects. In Russia, Italy, and England, the blow is estimated on the power of the shot to perforate, and this he says is true enough when wrought iron is the target, but where steel faces are used, and perforation is not effected, the action is more that of a pointed wedge striking and splitting the plate before it has entered very far. The effect would probably be proportional to the total energy of the blow delivered, but without reference to the full diameter of the shot, which never comes into play; thus the advantage of a small diameter would not be apparent. With a steel-faced target, the shot are generally matched against the plate on two standards. On the lower one, the shot has just sufficient power to perforate wrought iron of the same thickness. On the higher standard it has sufficient penetrating power to perforate a wrought iron plate of perhaps 20 per cent. more thickness than the plate. The lecturer illustrated his meaning by the following example:

A 9 in. Woolwich gun and 5¾ in. Krupp were fired in comparison; the former had 118 foot tons of energy per inch of circumference, and the latter 123. Their penetration, according to the wrought iron standard, would therefore be about the same, but their total energies were respectively 16,400 and 5,800 foot tons. It seems absurd that these two should be taken as having the same effect on steel armor.

The lecturer then illustrated his meaning practically with three bullets of the same weight shaped like punches, with diameters of ¼ in., ⅛ in., and 1 in. respectively. His object was to test the two systems by comparing the projectiles. The equation of drop being $WA = \pi D t^2 K$, where

W = weight,
h = height of fall,
D = diameter of the projectile,
t = thickness of sheet punched,
K = some constant,

it follows that everything else being constant the height from which the projectiles must be dropped in order to perforate a soft material will vary with the diameter. The experiment was then shown as follows. A piece of felt was used as representing the soft armor, and the 1 in. diameter projectile perforated it when dropped from a height of 60 in.; the projectile with the ¼ in. diameter being then substituted, it was found that a drop of 15 in. sufficed for perforation. In order to show the difference in the case of hard plates, brick was taken as the material, and the ¼ in. broke it from a height of 19 in.; the same weight of the projectile with the 1 in. head broke another similar plate from 25 in., hence the law of perforation cannot be taken as giving a measure of the relative powers of the projectile in this case. The lecturer then proposed, as a check on the perforation standard, to divide stored-up work by the number of tons in each plate and thus get the shock per ton of plate. He admitted, however, that the question is full of difficulties, and that it is by no means easy to fix a fair standard.

Turning to the consideration of projectiles, he maintained that more experiments should be tried with our projectiles against foreign armor, such as Gruson's, and that we should ourselves further the manufacture of steel projectiles by all means in our power. He attributed the hanging back of the manufacturers in submitting steel projectiles for trial to their inability to obtain plates to test these projectiles on, beforehand. Hence when the projectile is submitted it is really only in an experimental stage, and manufacturers are not willing that their reputation should be endangered in this way. He suggested that the plates left from previous experiments should be used for this purpose. As a matter of fact, we understand that this has already been done with the plates tested in the Nettle at Portsmouth.

Captain Browne considered that experiments against hard armor are specially needed in this country, and maintained that our service projectiles have never been tried against either Schneider steel or Gruson's chilled iron. As the lecturer very wisely remarked, it is against foreign armor we will have to contend, and therefore our projectiles should be capable of damaging it. He said that Krupp had tried chilled projectiles against Gruson's armor, and they failed to do anything, simply breaking up, and that eventually he had to use steel shot. Finally, the lecturer summed the points of his lecture as follows:

1. The need of a better system of estimating effects on hard armor.
2. The need for developing the manufacture of steel projectiles.
3. The necessity of making trials against Gruson's or other very hard armor.

An animated discussion followed, in which Admirals Boys, Hamilton, and Selwyn, Sir Chas. Nugent, Captain McKinley, R.A., and Mr. Walter Browne took part. Nothing throwing much light on the points raised came out in this discussion. Admiral Selwyn considered that the principle of the anvil was the one we ought to go on, but Mr. Walter Browne, and the lecturer in his reply, did not think the two cases analogous. It appears to us that all the lecturer's points are worthy of serious attention. Krupp appears to have manufactured good steel projectiles, and there is certainly no sound reason why we should be behindhand in this matter.

SPEED EXPERIMENTS WITH SHIPS' MODELS.

THE POWER REQUIRED, ETC.

UNDER this title a paper was lately read before the Dumbarton Philosophical Society, by Mr. Edwin R. Mumford, head of the staff employed by Messrs. William Denny and Brothers, Dumbarton, at the experimental tank connected with their large establishment.

The object of this paper was to describe a particular method of measuring the resistance of ship's models at any given speed, and to show that from the results so obtained the resistance of the actual ship, and consequently the horse-power, could be determined with a considerable degree of accuracy. The method is that which the late Mr. William Froude, of Torquay, originated in 1872, and which was adopted by the late Mr. Tideman, of Amsterdam, and more recently by Messrs. William Denny and Brothers, of Dumbarton, who have the honor of taking the lead of all other shipbuilding firms in this matter. Experiments have of course been made by others previous to Mr. Froude; but none, before or since, have made model experiments so practically useful and trustworthy as Mr. Froude has done. It was he who, partly by theory and partly by actual experiment, discovered the law of comparison between the resistance of a ship and its model.

Before proceeding to describe the method of measuring the resistance of a ship's model, the lecturer gave a detailed and interesting account of how models were prepared for experimental purposes. Paraffine, for several reasons, was found to be the most suitable material with which to make models. It has no grain, and is very easily cut. It melts at about 130 deg. Fah., thus making it an easy matter to cast a model approximately to her correct form. It does not absorb water and thus swell and become heavy, as wooden models would most certainly do. Lastly, there is little or no waste of material, for when a model is finished with it can be broken up and remelted to make another model; all shavings and cuttings can also be gathered up and remelted. Given a sufficient quantity of paraffine and a large trough of blue clay, a mould is made in the clay roughly to the size and shape of the model, and a core prepared. The models, it should be stated, used at Torquay and at Lever's shipyard are usually from ⅜ in. to 1¼ in. in thickness, and vary in length from 12 ft. to 20 ft. The core is secured in such a way as to prevent its rising when the liquid paraffine is run into the mould. To prevent the core being crushed by the pressure due to the head of liquid paraffine, it is filled with water sufficiently to balance the outside pressure. When the model is cast and become cold the core is removed, and marks are put on to guide in the after process of cutting and shaping. After this is done the model is floated, by water pressure, out of the mould, and placed bottom up on the bed of the shaping machine, which is so designed that a pair of revolving knives can be made to cut out any water line on the model by making a tracer, which is connected to the knives by a system of levers, trace out the corresponding line on a suitable drawing, the drawing being fixed to a board which is geared to the bed of the machine. Having a series of water lines cut, it is a very simple matter to fair off the model by hand.

The model is then accurately weighed and placed in the water, and the difference between the required displacement and the weight of the model is made up partly by the wooden frame or barness which must be fixed on the beams, but principally by canvas bags filled with small lead shot and by lead weights. The shot bags are, of course, placed in the bottom of the model; but the lead weights are placed on top of the harness, and can easily be moved longitudinally or transversely, so as to give the model any required trim.

The model is towed by means of a carriage drawn along a straight and level railway, 18 in. above the water level, and any speeds between the limit of 50 ft. per minute and 1,000 ft. per minute can be assigned to the carriage by means of a stationary steam engine, which winds upon a drum a steel wire rope attached to the carriage. But in order to explain how the model is attached to the carriage it is necessary to describe the harness, which consists of a wooden frame 10 ft. long fastened to the beams of the model by means of dowels. At each end of the harness two pieces of wood are fixed with their edges parallel, so that two brass wires which are hinged to the bottom of the carriage, one at each end, hang between the parallel edges respectively; the wires are hinged so as to be free to move longitudinally, and serve to guide the model; for, although allowing the model to move freely longitudinally and vertically, they effectively prevent the model moving transversely. The ends of two long wooden levers—whose fulcra are on one of the beams of the carriage—pass between two transverse beams of the harness; these levers give the operator a means of controlling the model by hand when the speed is accelerating or retarding, the force required to accelerate the mass of the model being altogether too great for the weak springs which are used to measure the resistance at a uniform speed. When the speed is uniform the model is freed from the controlling levers, and is simply towed by a rod which is inside the model and at about the water level, the rod being suspended from the harness by means of a wire, and hooked to a steel knife edge at the bottom of the dynamometer.

The dynamometer consists of two levers or bell cranks—one above the other—each supported by steel knife edges which rest on rocking pieces. A spiral spring, fixed at one end, is hooked to a knife edge at the upper end of the lower lever, so that the extension of the spring is a measure of the resitance of the model; this extension is magnified very much by means of the upper lever, and is automatically recorded on paper, wrapped around a revolving cylinder, by means of a pen which is attached to a rod resting on the top of the upper lever, so that the mean position of the pen, during an experiment, is a measure of the extension of the spring, and consequently of the resistance of the model. To convert the position of pen into resistance of model, a scale of force is taken on each sheet of paper by hanging suitable weights on to a knife edge, which is at the same horizontal distance from the center of the lower lever as the vertical distance—from the same point—of the knife edge to which the model is attached, so that these weights have the same effect on the spring as equal forces applied horizontally and longitudinally to the model, the moments being equal. The position of the pen corresponding to each weight hung on is marked on the paper; thus a scale of force is obtained, and the geometry of the apparatus is such that the scale is uniform within the limits made use of. The speed is automatically recorded on the same sheet of paper as the resistance by a pen that is moved on one side every half second by means of a clock which makes electric contacts; the cylinder is driven off the axle of the carriage, so that distance along its circumference, normal to the axis, is a measure of distance traveled by carriage. Thus by measuring the total length of a certain number of half seconds of time, a measure of the speed is obtained; but in order to guard against errors due to the slip of driving band, stretching or shrinking of paper, etc., a check on the distance is made by another pen, which marks a line by the side of the "time" pen, and is moved on one side every time the carriage moves 10 ft. by means of small pieces of wood placed 10 ft. apart by the side of the railway, and which make electric contact by striking a trigger at the bottom of the carriage.

The strophometer is another instrument which automatically records the speed on a smaller scale, yet it is very essential, because the diagram obtained from it shows at once the variations, if any, in the speed. It consists of two weights attached to flat steel springs, one end of each spring being attached to a V-wheel, while the other end is attached to a spindle, which is free to move through the fixed axis of the V-wheel. The wheel is driven off of the axle of the carriage, and the centrifugal force of the weights deflects the springs and moves the spindle; the motion of the spindle is communicated to a pen, which marks on the same sheet of paper as the speed and resistance diagrams, so that the position of the pen is a measure of the centrifugal force, consequently it is a measure of the speed of the carriage; and the strophometer is so sensitive that the slightest variations in speed are faithfully recorded. At each end of the carriage a vertical cylinder is placed, each cylinder being driven off the axle of the carriage. Vertical rods, which rest on fixed points on the harness—one at each end—mark by means of pens on sheets of paper, which are wrapped around the cylinders, so that the rise or fall of the ends of the model is recorded.

Having described how all the diagrams are obtained, it is necessary to explain how the speed and resistance of a model is converted into speed and horse power for ship; and it is here that Mr. Froude's law is indispensable. Mr. Froude discovered that for two vessels of similar forms—for instance, a ship and her model—the corresponding speeds are to one another as the square roots of the similar dimensions; and at these corresponding speeds, the resistances of the two vessels are to one another as the cubes of the similar dimensions—*i. e.*, as the volumes—subject to a correction for what is called "skin friction," and which will be referred to presently.

Let l and L = lengths of short and long vessels respectively.
" v " V = corresponding speeds.
" r " R = " resistances.

Then $\frac{V}{v} = \sqrt{\frac{L}{l}}$ and $\frac{R}{r} = \left(\frac{L}{l}\right)^3$.

Example: Suppose it is required to find the effective horse power—*i. e.*, the horse power required to tow a ship regardless of friction of engines, etc.—of a ship 300 ft. long at a speed of 15 knots. Let the length of the model be 12 ft., then the speed of the model corresponding to fifteen knots for the ship $= 15 \times \sqrt{\frac{12}{300}} = 3$ knots. Assume the resistance of the model at 3 knots to be 4 lb. Then the resistance of the ship at 15 knots will be $\left(\frac{300}{12}\right)^3 \times 4$ lb. Bringing this to horse power it becomes—

$$\frac{(25)^3 \times 4 \times 15 \times 6{,}080}{60 \times 33{,}000} = 2{,}879 = \text{E H.P.}$$

The lecturer then explained in simple terms the theories as to fluid resistance, so well known to all who are acquainted with the work of Mr. Froude, and showed why a correction had to be made for skin friction.

In addition to measuring the speed, resistance, and trims of the models, the waves created by them are also measured and drawn on paper, and these waves agree, not only in theory with the waves created by the ship, but they have been proved, by observation, to agree both at the Torquay tank and at Messrs. Denny Bros.' tank, and it is easily seen that the information thus obtained is of great value, for it is a very important matter in designing a vessel—especially a paddle steamer—to place the propeller in such a position that it will do its work with the maximum efficiency, and the positions and heights of the waves created by the vessel have a great deal to do with the efficiency of her propeller.

With each ship model that is made, either at Torquay or at Messrs. Denny's, a series of experiments is made at various displacements and various trims, and in each condition several speeds are taken, varying between speeds corresponding to 5 knots and 20 knots—or higher—for the ship, the difference between consecutive speeds being, in any case, not greater than half a knot for the ship, and the simplest forms to which the results are reduced were shown in diagrams. The surface friction correction is plotted in the form of a curve, so that in calculating the resistance of the ship, measurements must be made between the surface friction correction curve and the curve of resistance of model. This must be increased as the cube of the corresponding dimensions, and also as the density of salt water to fresh water; this will give the resistances at corresponding speeds for the ship, and may be converted into effective horse power and plotted. If a curve of indicated horse power be plotted, it may be seen that the indicated horse power is about double the effective horse power, thus showing that about 50 per cent. of horse power is used up in friction of engines and screw blades, and in overcoming the extra resistance of the hull due to the action of the propeller is causing a diminished pressure at the stern.

Before closing, Mr. Mumford pointed out a very important matter with regard to indicated horse power curves not perhaps generally known to engineers and shipbuilders, viz., that an indicated horse power curve need not be what is called "fair," but may consistently have a "hump." Cases have been known where indicated horse power curves have been drawn in "fair," although the spots showed a decided hump; yet this hump has afterward been proved to be genuine in cases where a model of the same ship has been tried, it being borne out by the effective horse power curve deduced from the model experiments. The present Mr. Froude, of Torquay, has discovered the cause of these humps, and treats of them in a paper which he read before the Institute of Naval Architects in 1881. The following explains the cause: When a vessel is moving through water at a given speed it creates a wave the length of which is a function of the speed, consequently at certain speeds a crest of the created wave will be at such a point of the stern of the ship that the positive pressure due to the head of water will be most effective in pushing the ship forward, therefore at these speeds the indicated horse power curve is hollow. When the speed of the ship is such that a hollow of the created wave is at the same point, then it is easily seen that at that speed the indicated horse power curve is round. Hence in designing a vessel to go at a certain speed due attention should be paid to this matter, so that the hull of the ship may be efficient at the required speed.

SPEED ON CANALS.

AT a recent meeting of the Institution of Civil Engineers a paper was read on "Speed on Canals," by Mr. Francis Roubiliac Conder, M.Inst.C.E.

The important question of the resistance to the movement of vessels due to the size and form of channels or to the depth of open water through which they passed, was one as yet but little studied. Mr. W. Froude threw an entirely new light on the relations existing between speed and the proportion of vessels. A similar study was desirable as to the relations between speed and area and form of waterway. It was known that a great loss of speed occurred when a steam vessel passed from open water into a more or less restricted channel. Instances of this had been given in the *Proceedings* of the Institution. It was also known that a sudden and remarkable increase of speed accompanied the passage of a boat over an increased depth of water, even if it were a mere ballast hole in the bed of a river or canal. But neither the ratio nor the mechanical cause of this phenomenon had been clearly ascertained by hydraulic writers. In the most important inland navigation of the day, that of the Suez Canal, the low speed attained in the transit was one of the causes of the dissatisfaction felt by the commercial world, and the very small capacity of the canal for transport was painfully evident. The average speed at which vessels passed through the Suez Canal in 1882 was a little under two miles per hour; and if the speed were taken, not for the whole transit, but for the portion of time during which the vessels were actually in motion, it was only 5⅔ statute miles per hour in the year 1882. The greatest speed recorded as having been attained on the canal by any vessel since the opening of the route was 8·016 statute miles per hour in the year 1870.

The cross section of the Suez Canal was about one-half the area on promise of which the concession of the enterprise was sanctioned by the Porte, being 72 feet wide at a depth of 26 feet, instead of 144 feet wide at that depth. The sides were constructed with flat, shallow shoulders, the rush of water over which at once eroded the slopes, and dragged back the vessel under way. The sides were now being gradually protected by artificial stone. If a cross section of a semi-elliptical form had been adopted, with adequate side walling, in the first instance, for an equal quantity of excavation below the water line to that of the permanent canal, the hydraulic radius would have been double what it now was; the resistance to propulsion would have been proportionately less; vessels of four feet greater draught of water could have passed, and traffic in both directions at the same time would have been uninterrupted. By giving a larger cross section of the same scientific form, any conceivable amount of traffic could be carried on. The cost of the canal as constructed was returned at £143,585 per mile for execution (to the end of 1882), and £56,496 per

mile for management, financing, and interest of money, making £200,081 per mile in all. The cost, at fair contractor's prices, of the walled semi-elliptical canal, 163 feet wide at the top and 30 feet deep, came to £80,632 per mile; and that for the large section, 240 feet wide and 30 feet deep, to £112,280 per mile. The area of the present cross section of the canal was only three times as large as the immersed cross section of such a vessel as the Warrior. It was impasssble for modern vessels like the City of Rome or the Alaska (to say nothing of the Great Eastern), or for any vessel drawing more than 24 feet 9 inches of water. A mathematical calculation of the retardation caused by back current in the canal showed that in the case of such a vessel as the Warrior the retardation from this cause, due to the small size of the Suez Canal, was such as to reduce a speed in the open sea of 14·356 knots to one of 9·812 knots per hour in the canal. This was independent of the further retardation due to the bad form of cross section, and also of the direct retardation from shallowness and narrowness, which formed the subject of a separate mathematical investigation.

The various speeds attained on river and canal navigation in different parts of the world had been collected, and were shown in a tabular form. The sizes of locks, the time consumed in passing through locks, hydraulic lifts, and hydraulic inclined planes, and the dates of the river and canal acts of Parliament authorizing improvements in the inland navigation of the United Kingdom, were also tabulated. The loss of time at present experienced was reduced to a function of the changes of level overcome by a canal. The heights to be surmounted by different canal routes in crossing England were indicated, and the conclusion was arrived at that, by a scientific construction of canals and the application of steam power, a normal speed of five miles per hour—which was equal to the terminus to terminus speed of the mineral trains on certain English railways—might be readily attained on the inland water-ways of the country. For the cost of constructing and of working canals, reference was made to the thirty-seven pages of the report of the Select Committee on Canals in 1883, contributed by the author of the paper, and to his reports on the comparative cost of transport by railway and by canal, which were reprinted by that committee. The cost, both of construction and of working, on the railways and by canals of the United Kingdom, France, Belgium, and the United States; on the railways of New South Wales, India, and Pennsylvania; on the canals and lakes of America by steam colliers and by sea-going ships, was given in the appendix to the report of the select committee; and there was a statistical comparison between the capital cost and net earnings of the French and English railways, and of the mineral carrying and non-mineral carrying trunk lines among the latter. The cost of one-third of one penny per ton of cargo per mile was shown to pay working expenses and 5 per cent. interest on capital for canal transport, being about one-third of the cost of corresponding transport by railway. The actual limit of the work done on a double line of railway in various countries was shown in a table, and might be compared with the almost unlimited capacity for traffic of a first-class canal.

THE NEW AMERICAN WAR STEAMERS DOLPHIN, ATLANTA, AND CHICAGO.

DURING the last session of Congress, the construction of the smaller of the two cruisers provided for in the act of 1882 was reauthorized, and in addition two cruisers of about 3,000 tons displacement and one dispatch boat, for which $1,300,000 were appropriated. Mr John Roach, of Chester, Pa., the lowest bidder, obtained the contracts. The vessels are soon to be launched, and their completion is being rapidly carried on.

According to the act of Congress, these vessels were to be "constructed of steel, of domestic manufacture, having as near as may be a tensile strength of not less than 60,000 pounds to the square inch, and a ductility in 8 inches of not less than 25 per cent."

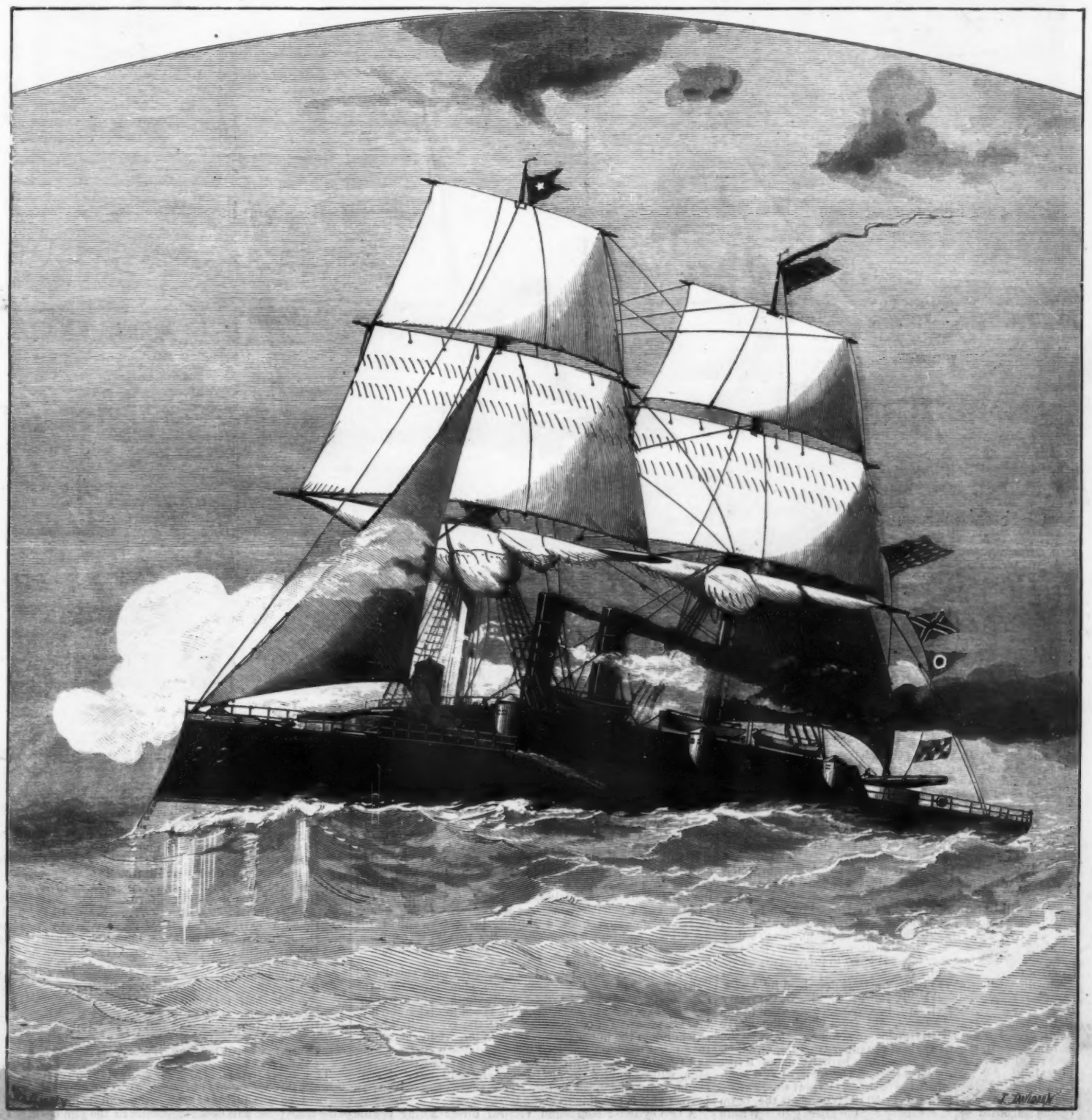
We present on this page an engraving of the single screw steam cruiser Atlanta.

The contract price for the hull, machinery, and fittings, exclusive of masts, spars, rigging, boats, etc., was $618,000. This steamer will have the following dimensions:

Length between perpendiculars	270 feet.
Length on water line	276 "
Length over all	283 "
Depth from garboard strake to under side of superstructure deck	34 "
Height of main deck port sill from load water line	11 "
Free board at extremities of superstructure	9 "
Breadth—extreme	42 "
Draught at load water line, mean	16 " 10 in.
Displacement at water line	3,000 tons.
Area of plain sail	10,460 sq. feet.
Complement of men	230
Battery, four 8-inch and six 6-inch B. L. R.	
Indicated horse power	3,500
Sea speed	13 knots.
Capacity of coal bunkers	580 tons.

There will be eight complete transverse bulkheads extending to the main deck, dividing the vessel into nine main compartments, one of which is occupied by the engines. Longitudinal bulkheads will extend on each side throughout the machinery space, forming side coal bunkers, which afford a coal armor of about 8 feet in thickness above the water line and an average thickness of about 5 feet below it. The coal bunkers will have a capacity of 580 tons, but nearly 200 tons more can be safely carried, thus giving an endurance of 2,500 miles at full speed, and 5,300 miles at 10 knots an hour.

The vessel will be divided into seventy-three water-tight compartments, and great care has been exercised in arranging the openings in order to make them really water-tight, the doors being arranged for manipulation either from below or from the main deck.



THE NEW UNITED STATES SHIP OF WAR ATLANTA.

The drainage has been closely attended to, and the total pumping power of the steam and circular pumps, with capacity of 2,500 tons per hour, can be concentrated on any main compartment. In addition there will be six continuous acting hand pumps on the berth deck, which will have independent suctions to each main compartment and each compartment of the double bottom; they can be used for flooding any compartment or flushing the drain pipes, and will deliver into the fire main or directly overboard as may be required.

The machinery spaces, for 100 feet, will be protected by a steel deck, 1½ inches thick, and this deck will be so placed with reference to the water as to afford the maximum protection to the buoyancy. The deck is to be stiffened at the sides by transverse frames in the lower coal bunkers, the brackets in the upper, the fore, and aft coal bunker bulkheads, and amidships by deep I-beams. An inner bottom will extend the length of the machinery spaces, forming a water-tight double bottom containing twelve water-tight cells. All of these cruisers will be fitted up with bilge keels.

The outside plating will be 23 pounds per square foot, with a double plate at the water line from the stem to near the stern. The fixed ammunition and shell rooms and the magazines are to be in the hold amidships, directly before and abaft the machinery space.

The motive power will be obtained from a three cylinder, compound, horizontal, back acting engine of 3,500 indicated horse power. The engine will have one high pressure cylinder 54 inches in diameter, and two low pressure 74 inches in diameter; the stroke being 42 inches. The cylinders will be located with their axes parallel, 9½ feet apart on the starboard side of the vessel. The crank shaft will be made in three interchangeable sections secured to the line shafting and to each other by couplings forged on the shafts. The low pressure cylinder cranks will be set at right angles, and the crank of the high pressure cylinder will be set between the others at angles of 135 degrees. The shaft will be steel, 16 inches in diameter at the main journals.

The screw will be 17 feet in diameter with a mean pitch of 20 feet, will have four adjustable blades, and will be made of steel.

Steam will be furnished by eight horizontal return tubular steel boilers placed forward of the engine and divided into two sets by a water tight bulkhead athwartship. Each boiler will be 9¾ feet long, 11⅝ feet in external diameter, and will have two cylindrical furnaces 43 inches in internal diameter, made of corrugated steel.

The disposition of the battery is thus described by Assistant Naval Constructor F. T. Bowles, U. S. N., Secretary to the Naval Advisory Board, in a paper presented to the United States Naval Institute, and from which the above items were condensed: "Outside the forward port angle, and the after starboard angle of the superstructure, an 8-inch long rifled gun will be mounted in a barbette about 3 feet high, built of 2 inch steel plates. The forward gun has a train from 40 degrees abaft the beam on the port side, sweeping the whole deck forward to 30 degrees abaft the beam on the starboard side; similarly for the after gun. Within the superstructure six 6-inch B. L. R. will be mounted; two, on each broadside, with a train of 60 degrees before and abaft the beam; one, forward in the starboard angle of the superstructure, may fight either through a forward or a broadside port, giving a total train of from 20 degrees across the bow to 60 degrees abaft the beam. The remaining gun is similarly mounted on the port side aft."

U. S. DISPATCH BOAT DOLPHIN.

The governing condition in the design of the Dolphin has been high speed capable of being maintained for several days. It is intended for a dispatch boat for furnishing rapid communication from the seat of government to any point on the coast, or to act as fleet dispatch boat if a United States squadron should need its services. In designing it all attempt at protection was abandoned, and machinery of the most durable and efficient type adopted.

The principal features of the Dolphin, represented in the engraving upon this page, are.

Length between perpendiculars	240 feet.
Length, extreme	256·5 "
Breadth, moulded	31·85 "
Breadth, extreme	32 "
Depth from top of floors to top of main deck beams	18·25 "
Depth from base line to top of main deck beams	20·07 "
Top of main deck at side above load water line	6·28 "
Mean draught	14·25 "
Displacement at mean draught	1,485 tons.
Complement of men	80
Battery—one 6-inch pivot, four revolving cannon.	
Indicated horse power	2,300
Speed	15 knots.
Capacity of coal bunkers	310 tons.

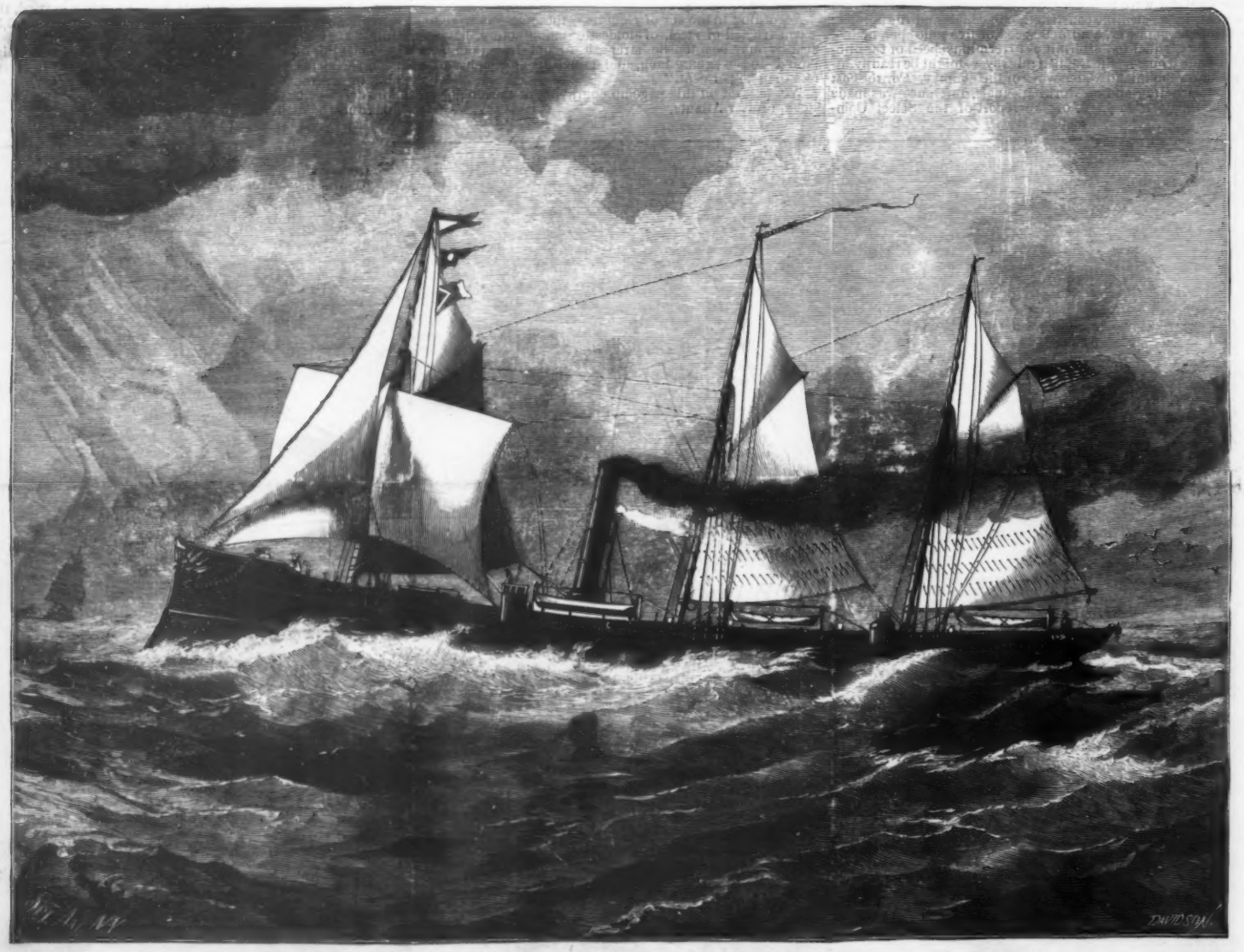
It will have a flush open spar deck, with no poop cabin or forecastle. Near the cabin gangway will be a small central deck house, and with the exception of another around the boiler and engine hatches, the deck will be uninterrupted fore and aft. The armament will consist of one 6-inch B. L. R. mounted upon a shifting pivot forward of the fire bridge, and four 47 mm. Hotchkiss revolving cannons, mounted at the end of each bridge in fixed armored towers.

It will have a three masted schooner rig with small and light spars and no head gear. The plan shows that the structural arrangements will be similar to those of merchant vessels, except that care has been taken to divide the hull into six water-tight compartments by transverse bulkheads extending to the upper deck. Greater longitudinal strength than usual has been provided for. The bow will be strong and slightly ram-shaped. It will have a steam steering engine, will be lighted by electricity, and will have electric search lights and head lights. The ventilation will be as perfect as it is possible to make it.

A two cylinder compound vertical direct acting engine of 2,300 indicated horse power will actuate the single screw. There will be one high pressure cylinder 42 inches in diameter and one low pressure 78 inches in diameter, the stroke being 48 inches. The cylinders are to be placed immediately over the crank shaft, each being supported by two wrought iron columns secured to the bed plate of the engine, and by two cast iron brackets attached to the condenser and also forming the cross head guides. The valves and levers for working and regulating the engines will be operated from the starboard side of a gallery running around the engines on a level with the berth deck. An upper gallery will be on a level with the spar deck. The propeller will have four adjustable blades 14 feet 3 inches in diameter with a mean pitch of 21 feet 4 inches

Cylindrical boilers will be used with a pressure of 100 pounds per square inch above the atmosphere. The grate surface will aggregate 270 square feet, and the heating surface 6,600 square feet. They will have internal cylindrical furnaces and horizontal fire tubes returning above the furnaces. There will be two single end boilers having a length of 9 feet 6 inches and a diameter of 11 feet, and each furnished with two furnaces. There will also be two double end boilers with a length of 18 feet 3 inches, and a diameter of 11 feet, each having four furnaces. The longitudinal axes of the boilers will be placed in a fore and aft direction, the single end boilers aft facing the double end, the fire room between them being 9 feet 6 inches. At the other end of the double end boilers will be a fire space 9 feet long. The fire room hatches and other openings can be closed air-tight.

The contract price for the hull, machinery, and fittings of the Dolphin, exclusive of the masts, spars, rigging, sails, boats, etc., was $315,000.

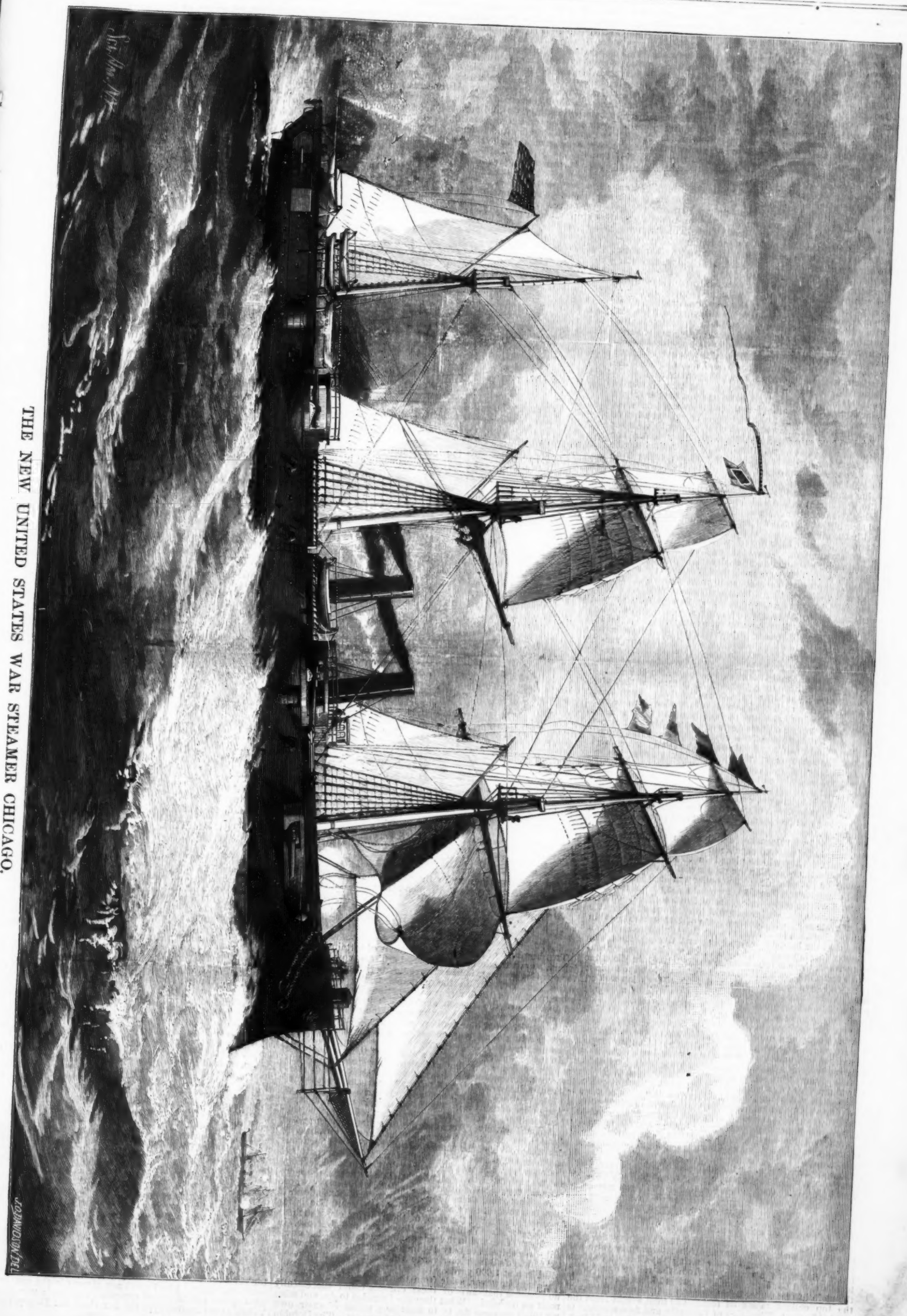


THE NEW UNITED STATES CRUISERS.—THE DISPATCH BOAT DOLPHIN.

U. S. TWIN SCREW STEAM CRUISER CHICAGO.

Length between perpendiculars	315 ft.
Length on water line	325 ft.
Length over all	334 ft. 4 in.
Depth, garboard strake to under side of spar deck	34 ft. 9 in.
Height of gun deck port sill from load water line	10 ft.
Height of spar deck port sill from load water line	18 ft. 6 in.
Breadth, extreme	48 ft. 2½ in.
Draught of water at load line, mean	19 ft.
Displacement	4,500 tons.
Area of plain sail	14,880 sq. ft.
Complement of men	300
Battery, four 8-inch long breech loaders in half turrets, eight 6-inch and two 3-inch on gun deck.	
Indicated horse power	5,000
Sea speed	14 knots.
Capacity of coal bunkers	940 tons.

This vessel, represented in the engraving on page 390, will be built throughout of mild steel, with no wood sheathing. It will be divided into ten water-tight compartments by nine transverse bulkheads extending to the gun deck. The boilers and machinery are to be in the four amidship compartments having a length of 136 feet. This space will have



THE NEW UNITED STATES WAR STEAMER CHICAGO.

a double bottom 3½ feet deep, divided into fourteen water-tight cells. A steel deck 1½ inches thick will cover the machinery.

These compartments will be divided on each side by vertical longitudinal bulkheads, and the space between them and the sides of the boat will be filled with coal. From the water line to 8 feet above it this coal armor will be 9 feet thick, and aft will have a thickness of 5 feet from the water line to 14 feet below it. When the doors are shut, the coal bunkers and the pockets in the boiler rooms form thirty-four water-tight compartments. The deck covering the machinery compartments will afford protection by preventing the access of shot and water to the main compartments, but it is not expected to resist a 6-inch shot even at inclinations of from six to eight degrees; entering shot would in all likelihood explode in the coal without doing injury to the machinery.

The magazine rooms will be in the hold amidships, before and abaft the machinery space. The deck above them will be covered by a protecting plating three-quarters of an inch thick. All hatches through it are to have water-tight covers, and coffer dams reaching to the berth deck will surround the magazine hatches. Other divisions in the hold by bulkheads of steel and the shaft alley bulkheads, together with those already noted, divide the vessel into eighty-five water tight compartments.

A system of drainage has been adopted by which the combined power of the steam and circulating pumps, having a capacity of 2,500 tons per hour, can be concentrated on any main compartment. In addition to this there will be six continuous acting hand pumps on the berth deck, having independent suctions to each main compartment and each compartment of the double bottom; they deliver either directly overboard or into the fire main, which will extend about three-fourths of the length of the vessel amidships on the berth deck, with stand pipes to gun and spar decks.

The outside plating of the vessel will be nine-sixteenths of an inch thick, will weigh twenty-three pounds per square foot, and there will be a double plate at the water line from the stem to within 70 feet of the stern. The stem and stern posts are to be of hammered steel. The water-tight inner bottom will be plating 10 and 12½ pounds per foot. The berth deck will have a protective plating over the engine and boilers for 136 feet. The bow of the vessel will be strengthened for ramming.

The rudder and steering gear will be below water line. A fighting hand wheel and steam steering engine will be placed on the water-tight flat, to which communication can be had by telegraph from the bridges. In addition there will be a hand steering wheel on the spar deck and a steam steering wheel in the pilot house.

The vessel will be bark rigged, with an area of plain sail of 14,880 square feet. The coal bunker capacity will be 940 tons, while 300 tons additional can be stored away on the berth deck. This will enable the Chicago to steam 3,000 miles at 15 knots or 6,000 miles at 10 or 11 knots per hour. The vessel will be ventilated by an exhaust system.

There will be twin screws operated by two pairs of two cylinder compound overhead beam engines, each of which will be placed in a separate water-tight compartment 22 feet long, and inclosed by a deck for protection. The high and low pressure cylinders will be situated side by side, are vertical, 8 feet apart, and 2 feet 1 inch and 3 feet 5 inches respectively from the midship line. The diameters of the cylinders will be 45 and 78 inches, and the stroke 52 inches. Each cylinder will be steam jacketed, and fitted with two double ported main slide valves, actuated by eccentrics through arms and rock shafts, each furnished with a steam cylinder and piston to balance the weight of the valves. The cut-off valves will be adjustable between the limits of one-eighth and five-eighths of the stroke. The exhaust steam from the high pressure cylinder will pass directly to the low pressure steam chests; suitable pipes will exhaust the steam into the condenser and atmosphere. The condensers will be furnished with tinned brass tubes having a cooling surface of 5,000 square feet each. Beside each condenser will be placed an independent, double acting, combined air and circulating pump. Worked from the crosshead of each pump piston will be two double-acting feed pumps 5 inches in diameter.

There will be fourteen horizontal return tubular boilers, constructed of steel, and capable of carrying a pressure of 100 pounds. They will be placed in two separate water-tight compartments. The fire rooms will run fore and aft, and will be 10 feet wide. Each boiler will be 9 feet in external diameter and 9 feet 10 inches in length on the bottom, and will be set inclining from front to back, over a single furnace. Each furnace will have about 57½ square feet of grate surface, or an aggregate of 802 square feet in all the boilers. The shells will be five-eighths of an inch thick, and the heads three-quarters and five-eighths. The tubes will be lap-welded iron. In each smoke pipe, concentric with it, there will be a steam drum 9 feet in diameter and 9 feet long, with a shell seven-eighths of an inch thick; this will have eight 18-inch and four 15-inch lap-welded flues passing through it. The fire rooms will be air-tight, and each will be provided with two large blowers.

The battery of the Chicago will consist of four 8-inch high powered breech loaders, weighing 12 tons each, mounted on the flush spar deck in projecting half turrets, the center of the trunnions being 20¼ feet above water. The turrets will be unarmored, and the men will be protected only by shields on the guns. Six 6-inch B. L. R., weighing four tons each, will be mounted broadside on the gun deck, which will also be arranged for two additional 6-inch guns if found desirable. One 6-inch will be mounted in a recessed gun deck port on each bow. Two 5-inch guns will be placed in recessed ports abaft the captain's cabin. The 8-inch projectile weighs 250 pounds, the 6-inch 100 pounds, and the 5-inch 60 pounds. In addition there will be four 47 mm. and two 37 mm. Hotchkiss revolving cannons, mounted in fixed bullet proof towers.

The contract price for the hull and fittings of the Chicago, exclusive of the masts, spars, rigging, sails, etc., is $889,000.

THE NEW WAR SHIPS.

To the Editor of the Scientific American:

I have been very much interested in examining the pictures of the Chicago and the Dolphin, as drawn in your paper. On constructing a scale, calling the Chicago 320 feet long, I find that the main mast from the rail to the trestletees is about 66 feet, the mast head is 15 feet, the man in the main top measured 8 feet, the top masts are 65 feet, and the top gallant masts 38 feet. The total height from the rail is 160 feet! The leech of the main and fore spencers is 75 feet, the mizzen 70 feet; the drop of the courses is 52 feet. The head of the main top mast above the water line is 146 feet, and as the space to clear the Brooklyn Bridge must not exceed 130, it is clear that the Chicago must house top masts to clear the bridge. The smoke stacks measure 35 feet above the rail. Looking at the picture in your journal, it might be said that the ship shows well on paper, and would be considered by navy experts a well rigged ship, spreading considerably more than 14,000 feet of plain sail. Comparing this picture with those published before by yourselves and others, it is very apparent that this one is a fancy sketch so far as the rig is concerned.

I propose, with your kind permission, to give you for publication two or three plans, showing a rig that can go under the Brooklyn Bridge without hurting any spars, and still contain more canvas than the rigs published under official authority.

Fig. 1 represents my idea as to how the Chicago should be rigged, *with steel masts all in one.*

Fig. 2 represents the same ship rigged with *steel lower only*, and pole upper masts *fidded* (not fitted) abaft.

Fig. 3 represents the same ship *stripped for battle* and ready to set top sails and fore course at a moment's notice. I have omitted *standing* rigging for the sake of more readily and *cheaply* illustrating my rigs. Seamen will readily understand the rig.

R. B. FORBES.

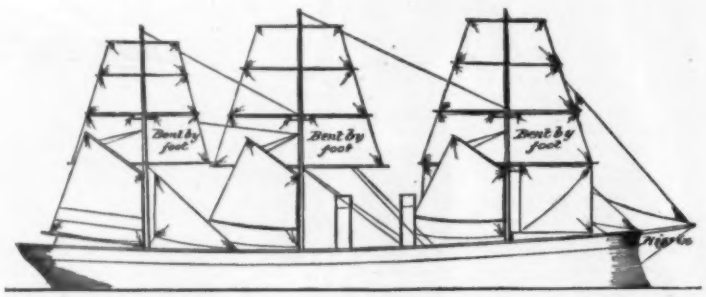


FIG. 1.—THE CHICAGO RIGGED WITH STEEL MASTS IN ONE PIECE.

The six upper sails bent by the foot and all clew down to the top sail yards.—Sails on fore and main are the same as those one flight higher. Fore sails come to deck.

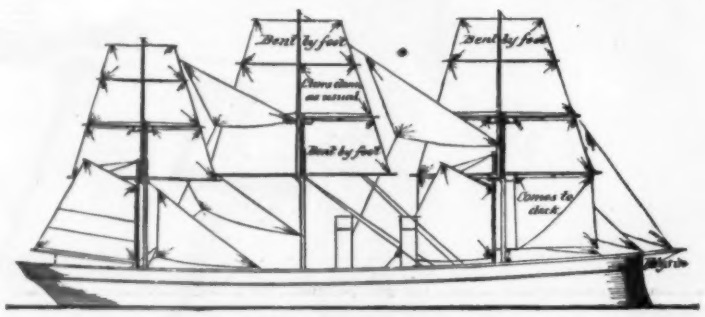


FIG. 2.—RIG ROR THE CHICAGO.

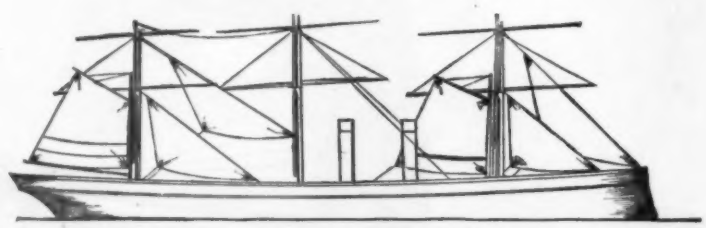


FIG. 3.—THE CHICAGO STRIPPED FOR BATTLE.

THE NEW STEEL CRUISERS.

By M. P. HAYES.

THE best way of answering the attacks of certain English journals upon the designs of the steel cruisers now building for our Government, is to compare them critically with vessels of similar classes in the principal navies of Europe; more particularly with recent constructions in the unarmored divisions of the French and English fleets. It can be shown that in most of the features to which attack has been so fiercely directed, our cruisers are superior to vessels of corresponding size and character in both the principal European navies.

In the first place, it must be stated that these cruisers are not intended for the line of battle. They are simply unarmored cruisers for the protection and attack of commercial ships in time of war and to carry the flag to distant ports in time of peace. They are very properly designated as "the police of the sea." Their function is rather to keep the peace than to make war. They must, of course, be able to defend themselves from enemies of approximate size and similar character and to escape by their speed from heavily armed ironclads of the enemy. It is therefore disingenuous and mere trifling with the subject, for English papers to say that they would be "defenseless against an ironclad." They are not intended to fight ironclads; nevertheless, there are several very costly ironclads in the English navy whose crews would find themselves in a very bad box indeed, if they had to meet the Chicago in the open sea. She is far superior to many of the ships of the Warrior class, such as the Hector, the Valiant, the Resistance, and Defense, in "end on" fire, and in the range and penetration of her guns. All these ships have only 4½ inch iron armor plating, while the Chicago's 8 inch long range rifles can pierce 9 inches of solid iron at 1,000 yards.

This is, however, aside from the main subject. There is no pretense that any of these cruisers could successfully meet an irodclad. What they are intended to do, and what we think they can do, is to meet any vessel of their own size and class, with a fair prospect of success. The Dolphin has a displacement of 1,485 tons on a draught of 14¼ feet. Her speed is to be 15 to 16 knots, and can probably be worked up to 17 on an emergency. The nearest vessel in the English navy is the Satellite, of 1,420 tons displacement and 15 ft. draught. Her speed is only 11 knots on the measured mile. There are a large number of small vessels of the Albatross class, ranging from 900 to 1,400 tons displacement, none of which would bear comparison for a moment with the Dolphin, either in speed or power. None of them have over 12 knots speed, and most only 11, while in armament they have only 64 pound M. L. Rs, or at most 90 cwt. M. Ls. The Dolphin could stand off, out of range of all their guns, and pelt them to pieces with her long 6 in. B. L. R. Not one of them could touch her. All the British boats of this class are either of iron or composite build; we cannot, therefore, get any exact data for comparison of cost, the Dolphin being of steel throughout. The cost of the Vestal for hull and machinery is £60,690 sterling, while the Dolphin for same items costs $315,000.

The Austrian navy has a class of so-called corvettes, which come very close to the Dolphin in displacement; they are of 1,360 tons and 11 to 12 knots speed. The French have no vessels exactly like the Dolphin. Their third class cruisers are all of wood, and have only a speed of 9 knots. The Germans have nothing between "corvettes" of about 2,000 tons and "gunboats" of 400 to 850 tons; and none of higher speed than 14 knots. We are safe then in concluding that, taken as a type of her class, the Dolphin is superior to anything as yet produced in European navies.

We next come to the consideration of the cruisers Atlanta and Boston. Displacement 3,000 tons, speed estimated at 15 knots. Armament 2·8 in. B. L. R.; 6·6 in. B. L. R.; 8 in. revolving cannon. The rifles are admirably arranged for "end on" fire. These ships have a coal capacity of 580 tons, well placed for protection in the side bunkers; they can carry 200 tons additional, which will enable them to steam 2,500 miles at full speed or 5,300 at 10 knots per hour. They have also a good spread of canvas.

In the English navy the Active, corvette, is of 3,080 tons displacement. Her speed is 14·97 on the measured mile; the Volage, same displacement, speed 15·08. These vessels are the only ones that come close to the Boston and Atlanta. Their armament is very inferior, consisting only of 64 pounder M. L. R. They have no protection decks, a feature in which they are certainly much inferior to the Boston and Atlanta, whose machinery and boilers are protected by a deck of 1½ inches of steel below the water line.

The French have a number of second class unarmored cruisers, but they are all built of wood and are inferior in speed and displacement. The Dugay Trouin is very close to the Boston in these particulars, being of 3,189 tons and having a speed of about 15 knots. She is built of iron, carries 430 tons of coal. Her armament consists of 5·7 3-8 in B. L. R., of which one fires right ahead, and four are placed in projecting half turrets on the spar deck, with a train fore and aft close to the line of keel. This vessel is the latest production of French designers, and is unquestionably superior to anything of her size and class in Europe. Her hull is of iron, cased with two thicknesses of teak. Her length is 290 feet and her beam 42·6 in. In midship section also she is very like the Boston, having the same dead rise, but her top sides tumble home more, and her fore and aft lines are somewhat finer. The French are always in the van as regards grace and beauty of appearance in their war vessels. Taken as the leading type for her class, the Dugay Trouin

presents a very interesting object for comparison with our second class cruisers; we, therefore, subjoin a tabular comparison of the leading features of the ships:

	Dugay.	Boston.
Length	290	270
Breadth	42·6	42
Depth	15·9	18
Draught, mean	17	17·6
Screws	Single.	Single.
I. H. P.	3,740	3,500
Displacement	3,180 tons.	3,000 tons.
Speed	15 to 16 knots.	15 knots.
Armament	5 5½-in. B. L. R. 5 46 pdrs.	2 8-in. B. L. R. 6 6-in. " 8 in. Revolving.
Spread of canvas	15,500 feet.	10,400 feet.
Protection deck	None.	1½ in. steel.
Coal and supply in bunkers	480 tons.	580 tons.

The French ship has a slight advantage in speed and spread of canvas, but this, we think, is more than counterbalanced by the Boston's decided superiority in armament and coal endurance, while her 1½ inch steel protective deck is a feature entirely absent in the French design.

There is another feature also in which the French are terribly defective—that is, in steam machinery. While adopting the compound system in their engines, in this design, they have stupidly adhered to the low pressure boilers. The Dugay's boilers are constructed to carry only 32 pounds of steam, while the engines have three cylinders for high pressure steam and three for low pressure. The consequence of this most absurd arrangement is obvious. They get no good of the compound system, the basis of which is high pressure steam. If they will persist in having low pressure boilers, what in earth do they want of high pressure cylinders? This is the old story that kept the English navy ten years behind the age in regard to the compound system. They proved beyond question that the compound system gave no economy of fuel with the old low pressure boilers. It took them ten years to find out that compound engines meant utilization of *high pressure steam*. It is, to say the least, curious to see the French, at this late day, apparently adopting the compound system and leaving out its most essential feature.

Of course, using six cylinders with 32 lb. steam, to do the work of two cylinders, must only result in a frightful waste of fuel on account of the enormous amount of friction without any expansive force of steam to do the work. Still, the Dugay Trouin is a fine ship, and after a while they will doubtless supply her with boilers capable of producing steam at 100 lb. pressure, and get some economy in their fuel consumption.

From the foregoing comparison with this finest ship of her class, we see that our Advisory Board have apparently made a decided hit in the design of the two second class cruisers, and if we can make nearly as good a showing for their "first class" effort in the design of the Chicago, we shall have reason to congratulate ourselves and the country.

The Chicago may be briefly described as an unarmored, coal-protected steel cruiser of 4,500 tons displacement and 15 knots speed; she is described at length in the *Army and Navy Journal* of the 8th Sept., 1883. This vessel has been made the subject of most bitter and hostile comment in *The Engineer*, an English journal of great pretensions to accurate knowledge on technical subjects. Her leading features are made the butt of ridicule. "There is no point in her design that cannot be condemned. She would be utterly defenseless against an ironclad. To go to sea in her would be to court destruction. Her engines are entirely unfit for any sea going vessel, much less for a man-of-war. Her boilers are such as no English engineer, in possession of his mental faculties, would think for a moment of putting into an ocean steamer of any kind. As for her protective deck of 1½ inch steel, over the boilers and engines, they cannot see what possible object it is to serve." It is too light for protection and too heavy for a deck. Her heavy guns "can never be used in action, for the reason that they have no protection except paltry shields, which would be penetrated by all the modern machine guns. Any vessel armed with such guns could prevent the 8 inch rifles of the Chicago from being fired," and so on.

There is not a single unarmored cruiser in the British navy which is not open to exactly the same remarks as to the subject of protection for their gun crews; and as to the protective deck, *The Engineer* will probably be surprised to learn that it is of the same thickness, but much superior in form, to the protective decks of several of the most recent additions to the British fleet. The protective deck of the Shannon, a vessel of over 5,000 tons displacement, and very nearly double the cost of the Chicago, is of 1½ inch iron, while the Chicago is of steel equal to two inches of iron. If 1½ inches of iron be considered good protection for the vitals of an English ship, it is not altogether unreasonable to assume that the same thickness of steel may have "some possible object" to serve in an American vessel of 500 tons less displacement.

But this is not all. The English Admiralty are now building on the Clyde three ships of nearly four thousand tons displacement each, and these ships are being fitted with steel protective decks of exactly the same thickness, and nearly the same form as that of the Chicago. This fact at once places *The Engineer's* criticism in its proper place.

We shall come to a tabular comparison presently of the Chicago with recent vessels of her class, but meantime we must deal with her more salient features, such as her engines and boilers, for which our English critic can find no language strong enough to express his contempt. The engines are beam engines, similar to those in use on the screw steamer Louisiana, the fastest vessel of the passenger line between New York and New Orleans.

The boilers are to be of the ordinary return flue tubular type, of circular form, and they are to be placed in firebrick settings, such as are in use in nearly all manufacturing establishments on land. They are to be capable of carrying an ordinary working pressure of 100 lb. of steam to the inch, and are to burn either hard or soft coal, as may be most convenient. It is quite true that this class of engine is novel in its application to war vessels, but it has many advantages over the horizontal direct acting engine in the saving of space, and our vertical inverted form in the comparative safety from hostile shot or shell which it affords. It has been found to answer well in the Louisiana, and there is no real reason why they should not give as good performance in the Chicago.

As to the boilers, it is nonsense for *The Engineer* to say that they must prove a failure, and that "to go to sea with such boilers is to court destruction." There are thousands of just such a type of boiler in use with high pressure steam all over this country and the Canadas. In the salt regions of Michigan and Ontario this is the type of boiler in universal use in all the salt and lumber mills. The water in these localities is fully as strongly impregnated with salt as the sea water used in boilers of ocean steamers at sea, often carrying a much larger percentage. Yet there is no trouble found in working these boilers; they last as long as any boiler can be expected to last with reasonable care. Of course it will not do to allow any considerable crust to form on the inside of the boilers just over the furnaces. Neither can this be allowed with safety in any other kind of boiler, the ordinary marine fire box boiler least of all; while this type has many advantages, notably its simplicity and the possibility which its circular form gives for attaining great structural strength with the least possible weight and extent of material in the shape of stays, etc. Also in the fact that a much more perfect combustion of the fuel can be obtained in a firebrick furnace than is possible in any kind of firebox boiler; hence the possibility of using ordinary bituminous coal without the enormous waste which would accrue under the firebox type. These boilers are also very much cheaper in first cost as well as in expense of repairs. It was certainly well worth while to try this type of boiler in one of the new vessels on account of the great economy likely to result from their adoption if they should prove a success, as we have very little doubt they will.

In comparing the Chicago with foreign cruisers, it is somewhat difficult to find ships of near enough size and general features to give a fair subject of comparison. The *first class* unarmored cruisers of European navies are of much greater size and power, while the second class are of much less. The English ships which come nearest to the Chicago in size are the Bacchante, Boadicea, and Euryalus, unarmored, iron, wood cased cruisers of 4,140 tons displacement. These ships have a speed of about the same as the Chicago, namely, 15 knots at sea; but they only carry 400 tons of coal in their bunkers as against the Chicago's 940 tons in the bunkers and 300 tons in other parts of the ship.

The armament of this class consists of two 4½ ton revolving guns and 14 similar guns on the broadside. These guns have very small armor piercing power unless they be fired with larger charges of powder than the guns were designed to carry. The guns, except two, are carried on the main deck, and have only broadside range. The efficiency of the battery has been sacrificed to the safety and comfort of the crews; though it is very questionable whether in action a gun's crew, exposed in an open barbette tower, is not really safer than the crews on the main deck of a broadside ship with a half inch iron or steel side only between them and the enemy's shot and shell fire. So far as the chances of being hurt by heavy shot or splinters, the men in the open barbette have a decided advantage in their elevated position, and in the fact that shot may pass pretty close without actually hitting them. In the broadside battery the men must suffer from every shot that strikes the ship's side anywhere near them. This was illustrated in the case of the glorious defence of the Huascar by the gallant Admiral Grau against two vessels of superior power. He was literally cut to pieces in the conning tower by splinters of the 4 inch armor. Had the Admiral been in an open barbette or an unprotected bridge, it is by no means impossible that he might have escaped the shot which hit the tower and caused his death.

This is now becoming so well recognized by the most experienced naval officers of the French and English fleets that all the most recent designs of cruisers of the first class have the open barbette as a leading feature. The utter ignorance of this leading fact displayed by the writer in *The Engineer*, where he speaks with such contempt of the unprotected position of the Chicago's gun crews, is alone sufficient to deprive that paper's review of any real value in the eyes of well informed naval men. Capt. Lord Chas. W. D. Beresford, the hero of Alexandria, one of the pluckiest and most enterprising post captains in the British service, in a recent letter to the London *Times* says:

"The French give it as their opinion, founded on actual practice, that the proportion of hits between a barbette and a broadside ship coming into range, passing at 60 yards, and going out of range, is three to one in favor of the barbette."

So convinced are the English naval authorities, at length, of this long recognized fact, that they are adopting it in the two first class armor belted cruisers, Imperieuse and Warspite, now being built for their government at an estimated cost of over $2,000,000 each. To return to our comparison of the Chicago, we have shown how superior she is to the Bacchante class of English ships, which come nearest to her in size and cost. There is another class of ships in the English service which have to be considered, namely, the Iris and Mercury, though they are more properly dispatch vessels, built entirely for speed and carrying only a very light armament. These ships are built of mild steel. They are of 3,750 tons displacement, and draw 19 feet 9 inches of water. They have both developed the extraordinary speed of 18½ knots per hour. They carry 500 tons of coal in the bunkers, and 200 tons extra when required. Their armament is composed of ten 64 pound rifles, mounted, four on each broadside and one each on the poop and forecastle. The guns have no protection except the bulwarks of ½ inch iron. They are placed on the spar deck. These vessels could not attempt an encounter with any vessel armed with long range armor piercing guns, such as those proposed to be carried by our cruisers. Their use is mainly to prevent the running of blockades by fast merchant steamers and carry small stores or dispatches to distant stations in time of war. They are very costly ships.

To get a close comparison with the Chicago is not easy. The second class cruisers of the French navy are mostly of wood, and only 3,500 tons displacement, or thereabout; while the first class are from 5,500 to 6,000 tons. We are, therefore, forced into a comparison with the Boadicea class of English vessels as the nearest in size of all the European ships:

	Boadicea Class.	Chicago.
Displacement	4,140 tons.	4,500 tons.
Draught	23·5 feet.	20·6 feet.
Speed	15 to 16 knots.	15 knots.
Coal capacity in bunkers only	400 tons.	940 tons.
Coal protection at sides of ship	3 to 8 feet.	5 to 9 feet.
Protective deck	None.	1½ in. steel.
Armament	16 4½ ton. 7 inch M. L. R. 2 68 pdrs.	4 8-in. B. L. R. 8 6-in. B. L. R. 2 5-in. B. L. R.
Weight of shot from whole battery	1,040 lb.	1,920 lb.
Weight of shot in end on fire	226 lb.	1,000 lb.
Armor penetration	4 to 5 in.	9 inches.
Complement of men.	350	300

We thus see that in all the essential features of ships of their class and size, our new cruisers bear favorable comparison with the best and latest productions of European designers, and that *The Engineer* has exhibited such complete ignorance of naval construction, actually now going on under his eyes at home, as to deprive his criticism of any professional value whatever.—*Army and Navy Journal.*

THE ATLANTIC AND PACIFIC SHIP RAILWAY.

WORK on the roadbed of the railway for carrying ships between the Atlantic and Pacific Oceans, projected by Mr. James B. Eads, across the Isthmus of Tehuantepec in Mexico, was formally commenced last year near Minatitlan, its northern terminus on the Coatzacoalcos River. As this enterprise unquestionably takes a foremost place among the engineering and commercial enterprises elaborated during this century, some account of its leading features will possess unusual interest.

Tehuantepec is the most northern of the several isthmuses which, with the States of Central America, form the connecting link between North and South America. Being twelve hundred miles nearer the former continent than Panama, the route over it possesses immense climatic as well as geographic advantages over the latter one. No less than five States of Central America lie between these two rival routes, viz., Yucatan, Campeachy, Guatemala, Nicaragua, Costa Rica, and also parts of the Mexican States of Oaxaca and Vera Cruz, and the Colombian State of Panama. In considering, therefore, the great superiority of the Tehuantepec route for all commerce between the British islands and the North Pacific Ocean, Japan, China, and the Orient, the fact should be kept in mind that between the locality where M. De Lesseps is striving to cross the American Isthmus and that where Mr. Eads has commenced to construct the ship railway, there exists a territory twice the length of Great Britain. To go by the way of the ship railway to California, British Columbia, Japan, the Philippine Islands, or China, we would pass through the Gulf of Mexico; but to go by Panama we must sail south to the Caribbean Sea, cross the lower end of the isthmus, and then sail 1,200 miles along its Pacific coast to the bay of Tehuantepec, where the ship railway crosses it.

That the ship railway project is one fraught with the most stupendous results may be readily seen when we consider the facts that the American Isthmus separates about 100,000,000 of the most enterprising, industrious, and enlightened people on the earth, inhabiting the North Atlantic coast of Europe and America, from 600,000,000 souls who inhabit the Orient and islands of the Pacific.

It is true that the sailing distances which separated England, France, Germany, and Italy from India, China, and other Oriental nations, have been greatly lessened by the Suez Canal, but these distances are almost insignificant when compared with those which the ship railway will annihilate. For instance, the greatest saving effected by the Suez Canal between London and Calcutta is about 4,500 statute miles; whereas the sailing distance by the ship railway from London to every port on the Pacific coast of North America will be lessened by nearly twice this vast distance, or about 8,250 miles.

The Suez Canal brought London and Canton about 3,500 miles nearer together by sea. The ship railway will save more than three times this distance between the great American metropolis and every port in British Columbia. It will lessen the sailing distance which to-day separates the Atlantic and Pacific ports of British America by a distance but little less than half the circumference of the world, and give a sea route between the Gulf of St. Lawrence and Vancouver's Sound only 50 per cent. longer than the railway route across the American continent.

The American Isthmus and the Cordilleras of North America constitute a narrow but almost impassable barrier to the interchange of the manufactures and productions of 40 millions of people in the Mississippi Valley and Atlantic States, not only with those of 10 millions of their countrymen to the west of them, but with the products of nearly a hundred million others on the islands and coasts of the Pacific, who are seemingly their nearest neighbors.

The ship railway will give to these descendants of the British Isles a sea route between their Atlantic and Pacific ports scarcely a thousand miles longer than the railway between New York and San Francisco, and it will give to the vast valley of the Mississippi a gateway equivalent to the discharge of its mighty river directly into the Pacific.

A work designed to effect such enormous benefits to the commerce of the world should commend itself with especial force to this country, which to-day is carrying more than 60 per cent. of that commerce. We learn, therefore, with great pleasure, that Mr. Eads intends within a brief period to present this subject to the attention of British capitalists and shipowners, with a view to soliciting their aid in carrying out this great work. Of course, the difficulty which stands in his way lies in the fact that large ships have never been carried any considerable distance overland, although ancient history refers to the fact, we believe, that the Athenian fleet was carried over the Isthmus of Corinth more than 2,000 years ago, while numerous instances of similar achievements are authentically recorded since then, and to-day canal boats and small steamers weighing between 100 and 200 tons, and small steamers are being transported by rail in America and Prussia.

The voluntary indorsement of the entire praticability of Mr. Eads' plan of ship railway transportation, by the most eminent engineers and ship builders in England and America during the last two years, the exhaustive examination of the subject by the United States Senate Committee, and its unanimous report in favor of it, have commended the enterprise to the confidence of a number of capitalists, who have formed a syndicate or provisional company, and supplied the necessary funds to make a thorough examination of the route from ocean to ocean, and to execute such portions of the road as are required by the terms of the concession which they hold from Mexico. This one of the most liberal ever granted by any government, and gives practically the entire control of the isthmus for ninety-nine years to the company which Mr. Eads is authorized to form.

Under the direction of Mr. Eads, president of the provisional company, a number of distinguished engineers have been engaged on surveys of the route, and they are now preparing estimates of the entire cost of the work, so as to enable the enterprise to be presented intelligently and reliably to capitalists and the public. Mr. E. S. Corthell is the chief engineer of the provisional company, and Mr. M. Van Brocklin its resident engineer. Mr. Corthell was Mr. Eads' chief assistant at the Mississippi jetties; he has examined the entire route across the isthmus, and has given especial attention to the harbors, making at the time a careful hydrographic survey of Coatzacoalcos River. The first surveys

made for Mr. Eads were conducted by Mr. Garay, a distinguished Mexican engineer, educated in France, and who was sent by the Mexican Government to present the merits of the Tehuantepec route in 1869 to the international canal convention at Paris. Mr. J. J. Williams was engaged by Mr. Eads on another part of the line with Mr. Garay. Mr. Williams surveyed the Panama route for the Panama Railway Company, more than twenty years ago, and discovered the lowest summit on that isthmus, over which the railway is now located. Thirty years ago, he assisted General Barnard of the United States Army in surveying the isthmus of Tehuantepec for a canal, and has since devoted several years in making surveys of that isthmus. The resident engineer, Mr. Van Brocklin, spent over two years on the isthmus as chief engineer of the railroad commenced in 1880 under the concession to Mr. Searned. Guided by the results of the surveys of other engineers, and the knowledge he had then acquired, Mr. Van Brocklin undertook the survey, last March, of a new route across Tehuantepec, which he completed recently, from harbor to harbor, with greatly improved results.

This engineer was also for four years engaged on the celebrated railroad in Peru which crosses the Andes at an elevation of 15,600 ft., the highest railway in the world. He was assisted in the recent survey of the isthmus by Mr. Deming J. Thayer, a young American engineer, who built a railway in Colombia from the Pacific coast to the Cauca Valley. We mention these facts to show that Mr. Eads has had the good fortune to secure the aid of very experienced engineers in his great work. All of these gentlemen speak in glowing terms of the heathfulness of the Isthmus of Tehuantepec. Mr. Van Brocklin had four surveying parties in the field from March last until November, not one of whom was sick at any time, and none of his assistants or men were invalided during his previous surveys. Mr. Williams, Mr. Garay, and Mr. Corthell all give similar testimony.

The heaviest gradient on the Atlantic side does not exceed 42 ft. per mile while that on the Pacific is only 52 ft.; for about eight miles, the remainder of the route will have no grades exceeding 26 ft. per mile. No exceptionally heavy work will be encountered either in cuts or embankments, and the entire road from the Coatzacoalcos River to the Pacific harbor will be only 134 miles long.

Appreciating the difficulty which engineers encounter when explaining by mere drawings any novel devices required to meet the ever increasing demands of commerce, Mr. Eads has wisely determined to construct a working model of the ship railway, which shall illustrate in miniature every detail of the work. By it will be clearly seen the great simplicity of the devices needed for raising and lowering the ships at the harbors, distributing their weight equally upon all the wheels of the cradle on which they will be borne, the precautions for supporting every part of them to avoid injury during their journey by rail, and the safe and rapid method by which they may be shunted to permit of their passing each other, or to change their direction so as to avoid curves in the railway tracks, or to enable them to be run out of the way for painting or repairing.

The ship will be 7 ft. in length, the car or cradle on which the ship is carried will be 6 ft. 4 in. long. The floating dock will be 7 ft. 6 in. long, and 30 in. wide, and the basin in which it floats will require about two tons of water to fill it. By this means the public will become familiarized with the method proposed by Mr. Eads for working the traffic upon this gigantic line of railway.—*Engineering.*

REORGANIZATION OF THE PATENT OFFICE.

SPEECH OF HON. ORVILLE H. PLATT, OF CONNECTICUT, IN THE SENATE OF THE UNITED STATES, MONDAY, MARCH 31, 1884.

On the bill (S. 1,924) providing for the organization of the Patent Office into an independent Department, and for giving it the exclusive control of the building known as the Patent Office and of the fund pertaining to that office.

Mr. Platt said:

Mr. President: I do not think that the bill which I have introduced is by any means a perfect bill. It is not original with me. It is a bill which was introduced, I think, in the Forty-fifth Congress by Mr. Phelps, a member of the House of Representatives from Connecticut. I am not aware that any action was taken upon it in the House, but it will serve to bring before the committee and before Congress a matter which I think is important, and the favorable consideration of which I think is essential to the best interests and welfare of this country.

The growth of our patent system, its vast importance, its intimate connection with and direct influence upon the property of the country, demand that it shall receive a degree of attention which it cannot and will not receive while it remains a merely subordinate bureau of the Interior Department.

The patent system has its foundation in the Constitution of the United States. In the grant of enumerated powers, article 1, section 8, and paragraph 8, we find this power granted to Congress:

"To promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

When the fathers wrote that clause into the Constitution of the United States, they builded better than they knew. They knew indeed that the prosperity of every nation must depend largely upon the progress of the useful arts. They knew that if this country was to attain the glory and the power which they hoped for it, it must be along the road of invention; but they could not, the wildest dreamer, the statesman with the most vivid imagination could never have dreamed, could never have imagined the blessings, the beneficial results which should flow and have flowed from the exercise of the power thus granted to Congress. The foundations which they then laid of our progress, our welfare, our strength, and our glory were granite, and we have builded wisely upon them; but I think that we may do much to improve the temple which has been reared.

I wish I knew the author of that clause in the Constitution. I have sought diligently in the records of those days that I might discover who he was. It was not in the original draft of the Constitution presented by Mr. Pinckney to the Convention on May 29, 1787. In that draft, immediately after the power given to Congress to establish post-roads, was the power to establish a national university at Washington; but when the Constitution came finally to be adopted, the power to establish a national university at Washington had disappeared from the orginal draft or plan presented by Mr. Pinckney, and the present clause granting Congress the power to promote the progress of the useful arts seems to have taken its place.

The first reference that I find to it is in the debates of the convention. In Elliot's Debates, volume 5, page 439, I find that on the 18th of August:

"*In Convention*—Mr. Madison submitted, in order to be referred to the committee of detail, certain powers, as proper to be added to those of the general legislature."

Among these proposed powers are enumerated the following:

"To secure to literary authors their copyrights for a limited time. . . . To encourage, by premiums and provisions, the advancement of useful knowledge and discoveries."

On the same day Mr. Pinckney submitted certain propositions as to the powers proper to be granted to Congress, among which was the power "to grant patents for useful inventions," also "to secure to authors exclusive rights for a certain time." The committee of eleven, through Mr. Brearly, reported on the 5th of September five clauses which it was proposed to incorporate in the Constitution. The fifth clause was the one relating to the progress of science and the useful arts:

"To promote the progress of science and the useful arts by securing for limited times, to authors and inventors, the exclusive right to their respective writings and discoveries."

It is *verbatim* the clause which is at present in the Constitution. It appears that this clause was agreed to without contradiction. It seems to have excited but comparatively little interest at that time. Very slight reference is made to it in the *Federalist*. The only reference that I find is in No. 43 of the *Federalist*, on page 338, a paper by Mr. Madison, in which he says:

"The fourth class comprises the following miscellaneous powers:

"1. A power to 'promote the progress of science and useful arts by securing for a limited time to authors and inventors the exclusive right to their respective writings and discoveries.'

"The utility of this power will scarcely be questioned. The copyright of authors has been solemnly adjudged in Great Britain to be a right at common law. The right to useful inventions seems with equal reason to belong to the inventors. The public good fully coincides in both cases with the claims of individuals.

"The States cannot separately make effectual provision for either of the cases, and most of them have anticipated the decision of this point by laws passed at the instance of Congress."

It had been the practice of the State legislatures in some of the States, and especially in the State of Connecticut, upon petition to grant patents to inventors. I am not aware that any public act providing for the granting of patents was ever adopted in any State prior to the adoption of our Federal Constitution; but I find that in Connecticut quite a large number of patents were granted upon petition. I have here a list of some of them, furnished me by the kindness of the State librarian, Mr. Hoadley:

Volume VI, page 25. To Edward Hinman, for making molasses from corn stalks; ten years; October, 1717.

Volume VI, page 79. To John Prout, etc., for making linseed oil; twenty years. October 17, 1718. A new grant to the same (page 143) for making linseed and rape oil. October, 1719; twenty years.

Volume VI, page 312. Ebenezer Fitch, slitting mill; fifteen years. May, 1723.

Volume VI, 572. Richard Rogers, making duck; seven years. October, 1725.

Volume VII, 174. Samuel Higley, etc., making steel; ten years. May, 1728.

Volume VIII, 395. Samuel Willard, etc., making potash; ten years. May, 1741.

Volume VIII, 388. Thomas Fitch, etc., making steel; fifteen years. October, 1740.

Volume IX, 281. Thomas Darling, making glass; twenty years. May, 1747.

Volume X, 231. Jabez Hamlin, etc., flax dressing; fifteen years. October, 1753.

October, 1783. Benjamin Hanks. A clock which will wind itself up; fourteen years.

1780. Mosely & Little. Exclusive privilege of making glass (probably they did not set up works). For January, 1783, exclusive privilege of making glass for twenty years was granted to William and Elisha Pitkin.

June, 1784. William Pitkin. Exclusive privilege of making snuff; fourteen years.

The references are to the published colonial records of Connecticut. One very curious thing appears by this list, curious in view of the fact that it is now asserted by men who have made diligent experiments that sugar can be profitably manufactured from cornstalks as well as sorghum, that the first patent ever granted by the Legislature of Connecticut should have related to this same system. It was to Edward Hinman for making molasses from cornstalks, ten years; the date, October, 1717.

A very full reference to the patents granted in Connecticut is to be found in the Patent Office Report of 1851, covering nearly fifty pages, and showing that a public act for the encouragement of the raising of silk in the colony of Connecticut was passed in 1732, from which I think it is fair to say the silk industry of Connecticut has grown.

It would be interesting to inspect one of the letters patent thus granted by State legislatures prior to the national Constitution. I have never seen one, but I find in a speech of ex-Senator Wadleigh, of New Hampshire, in the Forty-fifth Congress, that he said:

"An intelligent gentleman of my own State has referred me to an act of the general court of the colony of Massachusetts Bay, passed in 1646, granting to one of his ancestors, Joseph Jenks, the exclusive right of making and selling his improved scythe for the term of fourteen years. That, I think, was the first patent granted to an inventor in America. The improvement referred to changed the short, thick, straight English scythe into the longer, thinner, curved implement with stiffened back, now in use."

But the framers of the Constitution saw that the power to be effective must be a national power, must be exercised by the national Government rather than by the States. Congress soon passed a law. The first patent act was passed April 10, 1790. It was reported by a Representative from South Carolina, who was chairman of a committee of the House of Representatives appointed during the first session of Congress (several petitions having been presented praying Congress to grant patents for specified inventions) "to consider measures to promote the progress of the useful arts." That committee consisted of Mr. Burke, of South Carolina, Benjamin Huntington, of Norwich, Conn., and Mr. Cadwalader, of New Jersey; and I hope that the time is in the near future when Senators and Representatives from South Carolina will again join with Senators and Representatives from Connecticut and New Jersey in the passage of laws which shall have a tendency further to promote the progress of the useful arts and sciences by the perfection of the patent system and the emancipation of the Patent Office from the servitude to which it has been too long subjected. The traditionary history of this act is interesting, and I will ask the Secretary to read from the copy of the Official Gazette, published on the 23d of October, 1877, the passage which I have marked in reference to the history of this act.

The Chief Clerk read as follows:

"By act of April 10, 1790, the first American patent system was founded. Thomas Jefferson inspired it, and may be said to have been the father of the American Patent Office. He took great pride in it, it is said, and gave personal consideration to every application that was made for a patent during the years between 1790 and 1793, while the power of revision and rejection granted by that act remained in force. It is related that the granting of a patent was held to be in these early times quite an event in the history of the State Department, where the clerical part of the work was then performed.

"It is a matter of tradition, handed down to us from generation to generation by those who love to speak of Mr. Jefferson and his virtues and eccentricities, that when an application for a patent was made under the first act he would summon Mr. Henry Knox, of Massachusetts, who was Secretary of War, and Mr. Edmund Randolph, of Virginia, who was Attorney-General, these officials being designated by the act, with the Secretary of State, a tribunal to examine and grant patents, and that these three distinguished officials would examine the application critically, scrutinizing each point of the specification and claims carefully and rigorously. The result of this examination was that during the first year a majority of the applications failed to pass the ordeal, and only three patents were granted. In those days every step in the issuing of a patent was taken with great care and caution, Mr. Jefferson seeking always to impress upon the minds of his officers and the public that the granting of a patent was a matter of no ordinary importance."

Mr. Platt: The first patent act provided that the petitions for a patent should be addressed to the Secretary of State, the Secretary for the Department of War, and the Attorney-General, setting forth the invention or discovery, etc., and that the letters patent, if the same should be granted, should be made out in the name of the United States and bear teste by the President of the United States. They should be delivered to the Attorney-General of the United States to be examined, who should within fifteen days next after delivery to him, if he should find the same conformable to the act, certify the same at the foot thereof, and present letters patent so certified to the President, who should cause the seal of the United States to be thereto affixed.

Under this act the fees to be paid by the applicant were as follows:

"For receiving and filing the petition, 50 cents; for filing specifications, per copy sheet containing one hundred words, 10 cents; for making out patent, $2; for affixing great seal, $1; for indorsing the day of delivering the same to the patentee, including all intermediate services, 20 cents."

This act remained in force until the 21st of February, 1793, when a new act was passed and the old one repealed. Under the act of 1793, the petition was made to the Secretary of State alone. If the Secretary of State believed that a patent should be granted, he then referred the papers to the Attorney-General to be examined, who within fifteen days was required to certify the same as before.

In this act was included the right to assign the patent, and the fee was raised to $30. The practice under the act of 1793 continued without substantial change until July 4, 1836, when the act which is really the foundation of our present patent system was passed. Prior to 1836 there was no critical examination made of the application or of the state of the art to determine whether the alleged invention was really new or useful, or whether it had been anticipated by other inventions which had been patented.

I have here a report of all the patents which were granted by the United States prior to 1836, and a most interesting volume it is. The first was granted July 31, 1790, to Samuel Hopkins, for making pot and pearl ashes. An examination of the patents granted between 1790 and 1810 shows most surprisingly the germ of the ideas which by subsequent improvements have been incorporated into our inventive system.

Among the patents granted during the first ten years after the passage of the original patent law of 1790, was one for a "machine for thrashing wheat, etc.," to William Thompson; one for "propelling boats by steam, etc.," to John Fitch; one for a "machine for ginning cotton," to Eli Whitney; one for a "mode of preventing the progress of fire," to Benjamin Taylor; one for a "conjurer for cooking and boiling," to Thomas Passmore; one for an "improvement in stoves," to James McCallmont; one for "improvement in clocks, watches, and time-keepers," to Eli Terry; for a "telegraph (description filed)," to Jonathan Grant, Jr.; for a "machine for raising water (a perpetual motion)," to John Baptiste Aveilhe; for an "improvement in the plow," to John Deaver.

By the act of 1836 a board of examiners was created. The official system was not a very large one at that time. The Patent Office was created, but it was attached to the Department of State. It was provided—

"That there shall be established and attached to the Department of State an office to be denominated the Patent Office, the chief officer of which shall be called the Commissioner of Patents, to be appointed by the President, by and with the advice and consent of the Senate."

There were provided for said office, to be appointed by the Commissioner of Patents, with the approval of the Secretary of State, a chief clerk, an examining clerk, three other clerks, a machinist, and a messenger. That constituted in 1836 the entire force of the Patent Office. In 1849 the office was disconnected from the Department of State and attached to the Department of the Interior, which was then created. Section 2 of the act to establish the home department and provide for the Treasury Department an assistant Secretary of the Treasury and a commissioner of customs provided—

"That the Secretary of the Interior shall exercise and perform all the acts of supervision and appeal in regard to the office of Commissioner of Patents, now exercised by the Secretary of State; and the said Secretary of the Interior shall sign all requisitions for the advance or payment of money, etc."

About 10,000 patents had been issued prior to 1836. In the copy of the Official Gazette, to which I have heretofore referred, published on the 24th of September, 1877, I have the number of patents granted year to year from 1790 to

1836, which I will not stop to read, but will ask to have incorporated in my remarks. It shows that three were granted in 1790, thirty-three in 1791; the list gradually increased each year until in 1836 the number was 723.

The following is the statement referred to:

The number of patents granted each year from 1790 to July 4, 1836, is as follows: In 1790, 3; in 1791, 33; in 1792, 11; in 1793, 20; in 1794, 22; in 1795, 12; in 1796, 44; in 1797, 51; in 1798, 28; in 1799, 44; in 1800, 41; in 1801, 44; in 1802, 65; in 1803, 97; in 1804, 84; in 1805, 57; in 1806, 63; in 1807, 99; in 1808, 158; in 1809, 203; in 1810, 223; in 1811, 215; in 1812, 238; in 1813, 181; in 1814, 210; in 1815, 173; in 1816, 206; in 1817, 174; in 1818, 222; in 1819, 156; in 1820, 155; in 1821, 168; in 1822, 200; in 1823, 173; in 1824, 228; in 1825, 204; in 1826, 323; in 1827, 331; in 1828, 368; in 1829, 447; in 1830, 544; in 1831, 573; in 1832, 474; in 1833, 586; in 1834, 630; in 1835, 757; in 1836, 723.

To show the appreciation of the patent system at this time I read a single sentence from the report of the first Patent Commissioner, Henry L. Ellsworth, made to Congress for the years 1837 and 1838. He says:

"The Patent Office has been greatly subservient to the promotion of the arts and sciences, and its late reorganization will extend in a much higher degree its usefulness. Without the encouragement of the patent laws few inventions would become practically useful. By this encouragement a stimulus is given to talent and ingenuity, and the result of human effort seems almost incredible. The inventions of the day have proverbially overcome time and space. The numerous manufactories spread over all the country attest the patronage they have received from Government."

Remember that this was in 1838.

"Of late, however, inventors have directed their attention with peculiar interest to the improvement of the implements of agriculture, and many labor-saving machines have been patented, which are of the highest utility to the husbandman. These are rapidly increasing, and it is scarcely possible to conjecture to what extent the labor of the agriculturist may be diminished and the products of the country increased by these improvements. Already the process of sowing, of mowing, and of reaping is successfully performed by horse-power, and inventors are sanguine in the belief (and probably not without reason) that the time is not far distant when plowing-machines will be driven by steam and steam-power applied to many other operations of the husbandman."

Mr. President, to my mind the passage of the act of 1836 creating the Patent Office marks the most important epoch in the history of our development—I think the most important event in the history of our Government from the Constitution until the war of the rebellion. The establishment of the Patent Office marked the commencement of the marvelous development of the resources of the country which is the admiration and wonder of the world, a development which challenges all history for a parallel; and it is not too much to say that this unexampled progress has been not only dependent upon but has been coincident with the growth and development of the patent system of the country. Words fail in attempting to portray the advancement of this country for the last fifty years. We have had fifty years of progress, fifty years of inventions applied to the every-day wants of life, fifty years of patent encouragement, and fifty years of a development in wealth, resources, grandeur, culture, power, which is little short of miraculous. Population, production, business, wealth, comfort, culture, power, grandeur, these have all kept step with the expansion of the inventive genius of this country; and this progress has been made possible only by the inventions of its citizens. All history confirms us in the conclusion that it is the development, by the mechanic arts, of the industries of a country which brings to it greatness and power and glory. No purely agricultural, pastoral people ever achieved any high standing among the nations of the earth. It is only when the brain evolves and the cunning hand fashions labor-saving machines that a nation begins to throb with new energy and life and expands with a new growth. It is only when thought wrings from nature her untold secret resources that solid wealth and strength are accumulated by a people. Especially is this true in a republic. Under arbitrary forms of government kings may oppress the laborer, kings may conquer other nations, they may extort from, oppress, and degrade the men who till the soil, and they may thus acquire wealth; but in a republic it is only when the citizen conquers nature, extorts her resources, and appropriates her riches that you find real wealth and power.

We witness our development; we are proud of our success; we congratulate ourselves, we felicitate ourselves on all that we enjoy; but we scarcely ever stop to think of the cause of all this prosperity and enjoyment. Indeed, this prosperity has become so common that we expect it. Many men forget to what they owe it; many men, I am sorry to say, in these recent years deny the cause of it all. The truth is, we live in this atmosphere of invention; it surrounds us as do the light and the air; like light and air it is one of our greatest blessings; and yet we pass it by without thought. Some say that the cause of all this wealth, of all this influence in the world, springs from other sources; some say it is the result of our free institutions, of our Christian civilization, of our habits of industry, of our respect for law, of the vastness of our natural resources; but I say inventive skill is the primal cause of all this progress and growth. I say the policy which found expression in the Constitution of the United States when this clause was enacted giving Congress power "to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries" has been the policy that has built up this fair fabric.

Concede all you claim; free institutions, Christian civilization, industrious habits; grant respect for law; acknowledge all our vast natural resource; and then deduct patents and patented inventions from the causes which have led to this development, and you have subtracted from material, yes, from moral, prosperity nearly all that is worth enjoying. Subtract invention from the causes which have led to our growth and our grandeur and you remit us, you remit our people, to the condition of the people of Italy, of Switzerland, of Russia. If "knowledge is power," invention is prosperity.

Let us turn a moment from the present, and take one rapid glance at the past. Consider the country as it was fifty years ago. The cotton gin, the steamboat, the railroad, the power-loom, the printing-press, were indeed in embryo; but their development was partial and their use was extremely limited. It was still the age of home-spun, it was still the age of hand labor. Brain had not, so far as production was concerned, superseded muscle. We had then twenty-six States. When the commencement of our present patent system really began there were twenty-six States in the Union. Twelve new ones and eight Territories added since are, in my judgment, a tribute to the inventive genius of this country and to the perfection of its patent system. There are at least ten Senators occupying seats on the floor of the Senate to-day who would not be here but for the patent system of the United States.

Our conception of history in these days was only that of war and diplomacy. Industrial development formed no part of the history of a country in the estimation of statesmen and publicists.

Let me allude to my own State. I am not a very old man, but recollection carries me back fifty years, when there was no railroad, no coal used, no steam power used; no woolen factories except of the rudest sort; no telegraph in Connecticut. Possibly there were one hundred tons of coal consumed in the State annually. It is possible that there was that rude beginning of a manufacturing establishment in which steam was the motive power; but practically there were none of these improvements in Connecticut. The people were rural and agricultural; a few shops, water furnishing the motive power, were scattered up and down the streams of the State, but almost the entire population were engaged in agriculture. It was a time when the hand brake and the hetchel prepared the flax which was raised within her borders, when hand spinning and the hand-loom prepared it for use. My mind goes back and takes in the days of my early boyhood, when wool was carded by hand, when it was spun and woven by the mothers and the daughters, when it was then taken to the fulling-mill, and then come the tailoress, and in the household cut and made the cloth into garments for the use of the family. It was the pay of the village shoemaker, the day of the grist mill, the day of the stage coach, the day of the pillion. There was no carpet; no piano; few books; hand sewing only; hand knitting; the tallow candle; the unwarmed, unlighted church; the school house with its hard, rough benches; and the slow post route, the mail once a week; a weekly paper only. It was a week's journey from Connecticut to Washington; six weeks' journey from Connecticut to Ohio. Five thousand dollars in those days was a competence, and $10,000 was a fortune. What has accomplished all the transformation which we witness as we compare the condition of the country fifty years ago with its condition at the present day?

I insist, Mr. President, that it is traceable directly to invention. The railroad, the child of patent inventions, the production of cotton, silk, broadcloth, and linen, is due absolutely and entirely to the perfection of machinery for their manufacture. The daily press, the teeming books, are part of our civilization. They are all dependent upon patented inventions. The carpet, the piano, and the carriage conduce to our comfort and our convenience, and they also are children of patents. Every comfort which we have, every convenience which we enjoy, every element of wealth which we acquire, has its root and development in the patent system of this country. They are born of patents, and they live only by permission of patents.

To illustrate this proposition I ask the Senate to bear with a few statistics. I have said that the number of patents granted from 1790 to 1837 was about 10,000. The number granted from 1837 to 1884 is over 300,000. I present a statement, prepared at the Patent Office, showing the number granted year by year from 1836 until the present time, and it will appear by reference to it that in 1840 458 were granted, that in 1850 884 were granted, that in 1860 4,363 were granted, that in 1870 12,157 were granted, that in 1880, there not appearing to have been any greater increase during that decade, 12,926 were granted, and that in 1883 21,196 were granted. These are original mechanical patents, not including patents for designs and reissues.

I will also ask to have incorporated as part of my remarks a table showing the issue of patents year by year from 1837, with the cash received and cash expended, and the surplus each year, which has been paid into the Treasury of the United States, up to and inclusive of the year 1883.

I also present a table showing the number of applications filed month by month, commencing in 1880 to the end of February, 1884, showing the regular growth of the business of the Patent Office for that time.

Now, bearing in mind this wonderful development of patented inventions in the United States, this wonderful growth of the patent system, I ask the Senate to look at the corresponding growth and development of business, property and wealth in this country. Patented inventions and material prosperity have locked arms and joined each other in this march of progress and greatness.

Table showing the issue of patents year by year from 1837 to 1883.

Year.	Applications.	Caveats filed.	Patents and reissues.	Cash received.	Cash expended.	Surplus.
1837	.....	.....	435	$29,280 06	$33,506 98	.....
1838	.....	.....	620	42,123 54	37,402 10	$4,721 44
1839	.....	.....	625	37,260 00	34,543 51	2,716 49
1840	733	228	473	28,056 51	30,020 67	.....
1841	847	312	495	40,413 01	52,666 87	.....
1842	761	391	517	36,505 68	31,241 48	5,264 20
1843	819	315	510	25,315 81	30,776 96	4,538 85
1844	1,045	380	495	42,509 26	36,244 73	6,264 53
1845	1,246	452	504	51,076 14	39,595 65	11,480 49
1846	1,272	448	638	80,284 16	46,158 71	4,105 45
1847	1,531	553	569	63,111 19	41,878 35	21,232 84
1848	1,628	607	653	67,576 40	58,505 94	8,670 86
1849	1,955	595	1,088	80,752 98	77,716 44	3,036 54
1850	2,198	602	993	86,927 05	80,100 95	6,816 10
1851	2,258	760	872	95,738 03	86,916 93	8,821 05
1852	2,639	906	1,019	112,696 34	96,916 91	16,799 43
1853	2,873	901	961	121,527 45	132,802 60	.....
1854	3,328	868	1,844	163,780 84	167,146 32	.....
1855	4,435	905	2,012	216,459 35	179,540 33	36,919 02
1856	4,960	1,024	2,506	192,588 02	192,931 02	.....
1857	5,771	1,010	2,896	198,132 01	211,582 09	.....
1858	5,364	934	3,095	203,716 16	193,193 74	10,522 42
1859	6,225	1,097	4,504	245,942 15	210,278 41	35,663 74
1860	7,653	1,084	4,778	256,352 59	252,820 80	3,531 79
1861	4,643	700	3,329	137,354 44	221,491 91	.....
1862	5,030	824	4,502	215,794 99	182,610 29	33,184 00
1863	6,014	787	4,184	195,593 29	189,414 14	6,179 15
1864	6,932	1,063	5,025	240,919 98	229,868 00	11,051 98
1865	10,664	1,937	6,616	348,791 84	274,199 34	74,592 50
1866	15,209	2,723	9,458	460,665 38	361,724 28	133,941 10
1867	20,279	3,597	13,026	646,561 92	639,263 75	7,298 17
1868	20,420	3,705	13,410	681,565 86	628,679 77	52,886 09
1869	19,271	3,624	13,997	693,145 81	496,430 78	206,715 03
1870	19,171	3,273	13,333	669,456 76	557,149 19	112,307 57
1871	19,473	3,308	13,036	678,716 46	560,595 08	118,121 38
1872	18,246	3,090	13,613	660,720 39	665,591 01	94,133 62
1873	20,414	3,248	12,864	703,191 77	691,178 98	12,012 79
1874	21,602	3,181	13,500	738,278 17	679,288 41	58,989 76
1875	21,638	3,094	14,837	743,453 36	721,657 71	21,795 65
1876	21,425	2,697	15,505	737,987 65	632,542 60	105,445 05
1877	20,398	2,809	14,187	732,342 85	614,152 62	118,190 23
1878	20,280	2,755	13,444	725,375 55	593,082 89	132,292 66
1879	20,059	2,630	13,213	703,931 47	529,638 97	174,292 50
1880	23,012	2,400	13,947	710,685 32	536,825 17	210,820 15
1881	26,092	2,406	16,384	833,065 89	609,173 28	248,492 61
1882	31,522	2,553	19,267	1,000,219 45	683,867 67	325,351 78
1883	34,576	2,741	22,383	1,146,249 00	675,234 86	471,005 14

Number of applications filed.

Months.	1880.	1881.	1882.	1883.	1884.
January	1,859	1,847	2,324	3,003	2,981
February	1,908	2,011	2,327	2,936	3,130
March	2,336	2,422	2,954	3,302	.....
April	2,201	2,301	2,874	3,167	.....
May	2,031	2,395	2,883	3,089	.....
June	1,986	2,136	2,584	2,983	.....
July	1,991	1,977	2,417	2,520	.....
August	1,911	2,029	2,473	2,531	.....
September	1,632	1,772	2,301	2,468	.....
October	1,907	1,851	2,441	2,617	.....
November	1,477	1,898	2,325	2,602	.....
December	1,742	2,179	2,396	2,724	.....

The population of the United States has increased from 1840, and I take that decade because it is really the commencement of the expansion of the patent system of the country, from a trifle over 17,000,000 in 1840 to over 50,000,000 in 1880. I have the figures for each decade from 1840 to 1880:

	Population.
1840	17,069,453
1850	23,191,876
1860	31,443,321
1870	38,558,371
1880	50,155,743

The aggregate wealth of the United States has increased from about $7,000,000,000 in 1850, there being no statistics earlier than that, to over $43,000,000,000 in 1880.

The complete figures are given in the following table furnished me by Mr. Nimmo, Chief of the Bureau of Statistics,

Statement showing the number of the first patent, design patent, and reissued patent, and the number of the first certificate of registration of a trade-mark and of label issued in each calendar year since July 28, 1836, when the present series of numbers for letters patent commenced, together with the total number of each issued during the year.

Year.	Number of first patent and certificate issued in each calendar year.					Number of patents and certificates of registration issued during each calendar year.						
	Patents.	Designs.	Reissues.	Trade-marks.	Labels.	Patents.	Designs.	Reissues.	Total patents.	Trade-marks.	Labels.	Total certificates.
1836, July 28	3	.....	.....	.....	.....	109	.....	.....	.....	.....	.....	.....
1837	110	.....	.....	.....	.....	436	.....	.....	.....	.....	.....	.....
1838	546	.....	1	.....	.....	515	.....	9	.....	.....	.....	.....
1839	1,031	.....	7	.....	.....	404	.....	13	.....	.....	.....	.....
1840	1,465	.....	20	.....	.....	458	.....	10	.....	.....	.....	.....
1841	1,923	.....	30	.....	.....	480	.....	6	.....	.....	.....	.....
1842	3,413	.....	70	.....	.....	486	.....	13	.....	.....	.....	.....
1843	2,901	1	49	.....	.....	494	14	11	519	.....	.....	.....
1844	3,236	15	60	.....	.....	477	12	7	496	.....	.....	.....
1845	3,473	27	67	.....	.....	476	17	11	504	.....	.....	.....
1846	4,346	44	78	.....	.....	508	59	12	629	.....	.....	.....
1847	4,914	103	91	.....	.....	495	69	14	569	.....	.....	.....
1848	5,460	162	105	.....	.....	543	46	13	602	.....	.....	.....
1849	5,992	209	126	.....	.....	980	49	30	1,059	.....	.....	.....
1850	6,981	256	156	.....	.....	894	53	28	975	.....	.....	.....
1851	7,985	341	184	.....	.....	797	99	23	972	.....	.....	.....
1852	8,622	421	209	.....	.....	960	109	20	1,019	.....	.....	.....
1853	9,513	540	229	.....	.....	846	86	29	961	.....	.....	.....
1854	10,256	626	258	.....	.....	1,730	57	28	1,844	.....	.....	.....
1855	12,117	682	286	.....	.....	1,894	70	51	2,013	.....	.....	.....
1856	14,008	773	337	.....	.....	2,216	107	83	2,506	.....	.....	.....
1857	16,324	860	420	.....	.....	2,686	113	97	2,896	.....	.....	.....
1858	19,010	973	517	.....	.....	3,467	102	126	3,695	.....	.....	.....
1859	22,477	1,073	643	.....	.....	4,165	159	231	4,504	.....	.....	.....
1860	26,642	1,183	674	.....	.....	4,363	181	233	4,778	.....	.....	.....
1861	31,008	1,308	1,108	.....	.....	3,040	142	147	3,329	.....	.....	.....
1862	35,045	1,508	1,253	.....	.....	3,221	196	116	3,534	.....	.....	.....
1863	37,266	1,708	1,389	.....	.....	3,781	178	227	4,184	.....	.....	.....
1864	41,047	1,879	1,596	.....	.....	4,638	139	248	5,025	.....	.....	.....
1865	45,035	2,018	1,844	.....	.....	6,389	221	206	6,816	.....	.....	.....
1866	51,784	2,239	2,197	.....	.....	9,474	294	290	9,458	.....	.....	.....
1867	60,658	2,503	2,430	.....	.....	12,301	325	400	13,026	.....	.....	.....
1868	72,959	2,858	2,830	.....	.....	12,544	446	420	13,410	.....	.....	.....
1869	85,503	3,304	3,250	.....	.....	12,957	506	534	13,997	.....	.....	.....
1870	98,460	3,810	3,784	1	.....	12,157	737	439	13,333	121	.....	121
1871	110,617	4,547	4,223	122	.....	11,697	905	454	13,056	486	.....	486
1872	122,304	5,447	4,697	408	.....	12,209	894	529	13,613	491	.....	491
1873	134,304	6,326	5,216	1,099	.....	11,616	747	501	12,864	492	.....	492
1874	146,130	7,063	5,717	1,921	1	12,230	886	483	13,599	507	232	739
1875	158,230	7,909	6,200	2,150	233	13,291	915	621	14,827	1,138	232	1,370
1876	171,643	8,934	6,931	3,288	463	14,172	906	621	15,699	909	473	1,431
1877	185,813	9,988	7,452	4,247	957	12,920	600	568	14,187	1,244	502	1,906
1878	198,733	10,360	8,020	5,463	1,329	12,345	560	509	13,444	1,455	492	1,947
1879	211,078	10,975	8,529	6,918	1,921	12,133	592	488	13,213	872	325	1,197
1880	223,211	11,567	9,017	7,790	2,176	12,920	515	512	13,947	549	203	752
1881	236,137	12,062	9,523	8,139	2,379	15,648	565	471	16,384	526	252	1,039
1882	251,685	12,587	9,994	8,973	2,561	18,135	861	271	19,267	847	304	1,224
1883	269,820	13,508	10,265	9,920	2,805	20,196	1,030	157	22,383	903	906	1,909
1884	284,046	14,538	10,482	10,822	3,791	.....	.....	.....	.....	.....	.....	.....

but prepared, I think, by Mr. Dodge, statistician of the Agricultural Department:

Statement showing the true value of real estate and personal property in the United States for 1850, 1860, 1870, *and* 1880.

[From the United States Census Reports, 1870 and 1880.]

Years.	Total value of property.	Estimated value of slaves.	Total, less value of slaves.
1850	$7,135,780,228	*a* $640,862,600	$6,494,917,628
1860	16,159,616,068	*b* 988,440,000	17,171,176,068
1870	30,068,518,507		30,068,518,507
1880	43,642,000,000		43,642,000,000

a Estimated at $300 each. *b* Estimated at $250 each.

Now look at the increase of the value of manufactured products in the United States. I have no statistics for 1840, but in 1850 the value of manufactured products as given by the census was a trifle over $1,000,000,000; in 1880 it was $5,369,579,191.

I ask permission to insert the figures without stopping to read those of the intervening decades.

Value of manufactured products: 1840, not given; 1850, $1,019,106,616; 1860, $1,885,861,676; 1870, $4,231,325,442; 1880, $5,369,579,191.

Now, look at the increase in the value of farms, for I shall have something to say before I conclude my remarks on the relation of patented inventions to the agricultural pursuits of the country.

The value of improved farms in the United States for 1840 is not given in the census statistics. In 1850 it was $3,271,575,426—a little over three billions. In 1880 it was over ten billion dollars—$10,197,096,776.

The complete statement is as follows: Value of improved farms in the United States: 1840, not given in census returns; 1850, $3,271,575,426; 1860, $6,645,045,007; 1870, $9,262,803,861 (currency basis), $7,500,000,000 (gold basis); 1880, $10,197,096,776.

As to the value of farm products, there are no statistics of any value prior to 1880, because they were not taken separately. The census gives the value in 1880 as $2,213,402,564. The statistics of Mr. Dodge, of the Agricultural Department, and Mr. Nimmo, of the Bureau of Statistics, agree that the amount is not large enough, and fix the amount at $3,600,000,000 as the value of farm products in 1880.

Now look at the increase of cereal products. In 1840 the bushels of corn produced were 377,531,875; in 1880, 1,754,591,676 bushels. I have the totals from 1840 to 1880 of corn, oats, wheat, rye, barley, and buckwheat, which I will insert without reading:

	1840.	1880.
Corn	377,531,875	1,754,591,676
Oats	123,071,341	407,859,999
Wheat	84,823,272	459,483,137
Rye	18,645,567	19,841,595
Barley	4,161,504	43,977,495
Buckwheat	7,291,743	11,817,227
	615,525,302	2,697,581,229

The increase from 1840 to 1880, taking all cereals, has been 400 per cent. and more. We raised in 1880 of cereal products about fifty-four bushels to every inhabitant of the United States.

Look at the production of coal. I find no statistics back of 1870. In 1870, 32,000,000 tons in round numbers were produced; in 1880, 87,000,000 tons in round numbers.

But the increase in the production of wool is perhaps as significant as that in any other line of production. I submit a table showing the production and consumption of wool in the country for the years 1840, 1850, 1860, and year by year from 1862 to 1882. The production in 1840 was about 36,000,000 pounds, increasing until 1882, when the production was 290,000,000 pounds.

The following are the values of the imports and exports of the United States during the fiscal years 1840, 1880, and 1883. The fiscal year 1840 ended with September 30, the years 1880 and 1883 with June 30:

Imports of merchandise:	
1840	$98,358,706
1880	667,954,746
1883	723,180,914
Exports of domestic merchandise:	
1840	111,660,561
1880	823,946,353
1883	804,223,632
Exports of manufactured domestic products:	
1840	12,772,171
1880	79,510,447
1883	111,890,001
Exports of products of domestic agriculture, exclusive of raw cotton:	
1840	28,677,760
1880	474,425,186
1883	371,940,728
Exports of domestic raw cotton:	
1840	63,870,307
1880	211,535,905
1883	247,328,721
Exports of domestic provisions:	
1840	3,503,704
1880	127,043,242
1883	107,388,287
Miles of railroad in operation in the United States:	
1840	2,818
1880	93,543
1883	119,739

The business of the Post Office Department furnishes perhaps as reliable an index of the growth and prosperity of the country as can be gathered from any source, and some statistics are given, showing the increase of the postal-service revenues and expenditures from 1840 by decades to 1880 and for the year 1882.

Post Office Statistics.

Year.	Number of offices.	Miles of routes.	Revenue.	Expenditure.
1840	13,468	155,789	$4,543,522	$4,718,336
1850	18,417	178,672	5,552,974	5,212,953
1860	28,498	240,594	8,518,608	19,170,610
1870	28,492	231,232	19,772,221	23,998,837
1880	42,999	343,888	33,315,479	36,542,804
1882	46,231	343,618	41,883,005	40,482,021

It will be remembered that the reduction of postage from its highest figure has taken place during this period. It should be noted, too, that the mailable matter of to-day is almost entirely the result of the use of patents, and that it is transmitted by methods substantially unknown in 1836.

Here I desire to call attention to the report of Mr. Dodge, statistician of the Department of Agriculture, relating to the wages of farm laborers, which is Report No. 4 of the new series, an extremely interesting and suggestive report. He says:

"Miners, mechanics, and especially artisans and operatives engaged in productive occupations, are vastly more beneficial to agriculture, for two reasons: first, they augment the numbers to be fed and increase agricultural values; second, they make something themselves which farmers need, and reduce the prices of commodities hitherto brought from a distance at unnecessary cost."

Then he goes on to compare the amount of manufacturing in each State with the value of the lands in each State, and he says:

"The result of this comparison shows in every State, without exception, a higher average value of farm land in that portion of each State which makes the largest value of the products of manufacturing industry."

He contrasts two sections of each State, showing the value of farm lands in the counties having a certain amount of manufacturing carried on therein, which he classes as manufacturing counties, and the other counties, which he classes as non-manufacturing counties. For instance, there are in Alabama two manufacturing counties that produce annually more than $2 000,000. The value of land per acre in those counties is $6 55. The other sixty-four counties of the State are classed as non-manufacturing, and the value of the land per acre in those counties is $4.13. In Arkansas, in the manufacturing counties, the value of land per acre is $11.87; in the other counties $6.07. In Connecticut, where we have large manufacturing industries, in the manufacturing counties, that is, in the three counties where the manufacturing interest is large compared with the remaining counties, the value of the farm lands is $71.84 per acre; in the other counties it is $34.60 per acre. I think the more fertile lands are to be found in the counties which manufacture least, showing that the increased value in the manufacturing counties is due directly to the influence of the manufactories. In Georgia, in the manufacturing counties, land is worth $9.72 per acre; in the non-manufacturing counties, $4.10 per acre. In Kentucky, in the manufacturing counties, $36.48 per acre; in the non-manufacturing counties, $12.21 per acre. In Massachusetts, in the counties where most manufacturing is carried on, $57.87 per acre; and in the other counties, where less manufacturing is carried on, $34.55 per acre. In New Jersey, which heads the list, in her manufacturing counties, $96.46 per acre; in her non-manufacturing counties, $60.55 per acre. In all the other States the contrast is equally striking. The fact that such difference exists in every State shows that the higher value of farm lands in the manufacturing districts can only be accounted for by the direct influence which manufactories have upon the price.

I ask to have inserted in my remarks the table prepared by Mr. Dodge showing the higher land values in manufacturing counties, having grouped the same by States, to be found on page 27.

Statement showing higher land values in manufacturing counties.

FIRST GROUP.

States.	Manufacturing counties.		Other counties.	
	Acres.	Value per acre.	Acres.	Value per acre.
Massachusetts	1,292,876	$57 87	2,086,209	$34 55
Rhode Island	190,544	57 77	221,269	45 76
Connecticut	967,946	71 84	1,485,595	34 68
New York	4,981,545	62 37	18,799,209	39 65
New Jersey	398,675	96 46	2,561,098	60 65
Pennsylvania	3,930,549	36 73	15,860,792	40 02
Delaware	253,999	73 97	836,306	21 56
Total	11,989,074	71 85	41,900,472	40 33

SECOND GROUP.

Maine	2,288,037	28 12	4,264,541	12 13
New Hampshire	1,980,602	25 38	3,840,571	15 27
Vermont	344,860	30 07	4,537,728	21 81
Ohio	3,388,305	67 85	31,140,921	42 46
Michigan	1,500,690	40 23	12,306,550	35 65
Indiana	1,598,569	49 21	18,912,384	29 66
Illinois	4,470,593	43 96	27,203,142	29 89
Total	15,281,956	43 54	90,205,837	32 03

THIRD GROUP.

Wisconsin	4,720,777	33 93	10,632,341	18 60
Minnesota	1,508,251	28 24	11,804,788	12 96
Iowa	3,018,517	32 28	21,734,183	21 62
California	2,116,416	36 37	14,477,328	12 78
Total	11,363,961	32 90	58,736,618	17 14

FOURTH GROUP.

Maryland	1,904,199	$48 94	3,215,932	$27 49
Virginia	1,624,304	21 96	18,211,481	10 87
North Carolina	542,488	6 55	21,821,070	6 06
South Carolina	1,471,846	5 70	11,985,767	6 03
Georgia	995,971	9 22	25,047,511	4 10
Florida	5,736	14 45	3,291,565	6 14
Alabama	481,484	6 55	18,373,650	4 13
Louisiana	49,675	20 89	8,224,431	7 05
Texas	554,512	10 23	35,737,797	4 61
Arkansas	723,396	11 87	11,886,192	6 07
Tennessee	2,119,004	17 83	19,547,911	9 56
West Virginia	244,624	48 87	8,948,126	12 18
Kentucky	1,571,585	36 48	19,923,655	12 14
Missouri	2,309,339	21 41	25,560,937	12 76
Kansas	1,006,955	24 53	20,416,503	10 31
Nebraska	495,434	19 09	9,449,252	10 21
Colorado	78,317	44 19	1,067,056	19 91
Oregon	678,709	19 33	3,525,943	12 93
Utah	51,320	37 66	604,304	20 00
Total	15,306,290	21 95	267,674,722	8 27

Mr. Dodge also presents a convincing array of statistics showing that the price paid for farm labor is greater in the manufacturing States and districts, and increases in the country as the business of manufacturing increases. From his very able and instructive statement upon this question I extract the following:

"The State of Ohio, with only 40 per cent. in agriculture, pays comparatively high wages for farm labor because of its relative scarcity. Thus the northern part of the State, with Cleveland, Toledo, and other manufacturing cities, averaged in 1882, $25.96 per month. The western district, which is agricultural, with Cincinnati, Dayton, Springfield, and other manufacturing towns, averages $24.75. The eastern district has a larger agricultural element, and therefore a lower average, which is $22.65.

"Kentucky furnishes a fine contrast with Ohio. A river dividing one State with four-tenths in agriculture, the other with five-eighths, and most of the remainder commercial and professional rather than industrial, the average has been as follows:

States.	1879.	1882.
Ohio	$20 72	$24 55
Kentucky	15 17	18 20

"A part of this difference, a small part it may be conceded, comes from a larger proportion of negro labor.

"Illinois has a large proportion of its non-agricultural population in the northern counties. Dividing the State by east and west lines into three belts, the same result is seen, with quite as much contrast as between Ohio and Kentucky:

Northern district	$27 52
Central district	24 05
Southern district	19 87

"Comparing Illinois as a whole with Missouri, separated only by the Mississippi, with somewhat less diversification in industry and smaller interests in manufactures, yet with vastly more than Kentucky, the rates are as follows:

States.	1879.	1882.
Illinois	$20 61	$23 91
Missouri	17 59	22 39
Kentucky	15 17	18 20

"In every State the rate of wages is affected favorably by the presence of manufactures, whatever other causes of difference may prevail."

He concludes as follows:

"Assertions have been plenty that labor on the farms is not affected unfavorably by manufacturing depression, but here are facts, in perfect accord with all similar records from time immemorial, which disprove that fallacy, and show that the farm laborer is indissolubly bound up with the general

Quantities of wool produced, imported, exported, and retained for consumption in the United States by decades from 1840 to 1860, *inclusive, and annually from* 1863 to 1883, *inclusive.*

Calendar year.	Production.	Year ended June 30—	Imports.	Total production and imports.	Exports. Domestic.	Exports. Foreign.	Exports. Total.	Retained for home consumption.
	Pounds.		Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
1840	35,452,115		9,653,992	45,106,106	25,808	85,328	85,328	45,020,778
1850	52,515,955		18,669,794	71,185,753		35,000	35,000	71,150,753
1860	60,254,915		6,097,727	66,372,640	388,513	133,493	522,005	65,749,635
1862	102,000,000	1863	73,931,944	179,931,944	350,722	708,950	1,064,572	178,867,372
1863	103,000,000	1864	90,464,092	213,464,092	195,482	223,475	328,957	213,085,045
1864	112,000,000	1865	63,840,154	186,840,154	466,182	679,281	1,145,463	184,694,691
1865	155,000,000	1866	76,532,274	231,532,274	973,075	551,645	1,524,720	229,707,554
1866	160,000,000	1867	16,558,046	176,558,046	307,418	618,587	926,005	175,632,041
1867	167,000,000	1868	24,124,803	192,124,803	358,435	3,801,652	3,300,287	188,764,516
1868	123,000,000	1869	70,275,926	219,275,926	444,387	362,417	786,804	218,489,122
1869	132,000,000	1870	69,250,199	211,250,199	193,466	1,730,053	1,862,948	209,387,254
1870	160,000,000	1871	68,058,028	228,058,028	25,195	1,305,311	1,330,506	226,727,522
1871	150,000,000	1872	122,356,490	272,356,490	140,515	2,266,393	2,406,908	269,949,582
1872	158,000,000	1873	85,498,049	243,498,049	73,139	7,040,386	7,113,525	236,380,524
1873	170,000,000	1874	42,932,541	212,932,541	319,660	6,816,157	7,135,737	205,805,784
1874	181,000,000	1875	54,903,709	235,903,709	178,094	3,367,627	3,745,681	232,158,099
1875	192,000,000	1876	44,642,826	236,642,826	104,768	1,518,426	1,623,194	235,019,643
1876	200,000,000	1877	42,171,102	242,171,102	79,589	3,098,987	3,168,556	239,002,638
1877	208,200,000	1878	48,449,079	256,649,079	347,054	5,952,231	6,300,075	250,309,004
1878	211,000,000	1879	39,605,155	250,605,155	60,784	4,104,616	4,165,400	245,439,755
1879	232,500,000	1880	138,131,747	370,631,747	191,531	5,648,530	5,840,071	364,791,676
1880	240,000,000	1881	95,964,256	335,964,256	71,455	5,567,534	5,578,989	290,385,267
1881	272,000,000	1882	67,861,744	339,861,744	116,779	5,831,536	5,948,315	333,913,729
1882	290,000,000	1883	70,075,479	360,075,479	94,474	4,980,043	5,074,517	354,900,962

The data, as to production, furnished by Mr. J. R. Dodge, statistician of the Department of Agriculture.

Take the cotton and tobacco crops of the country. In the year 1850 the number of cotton bales was 2,469,093; in 1880, 5,755,359. The number of pounds of tobacco raised in 1850 was 199,752,655 pounds; in 1880, 472,661,157.

Take the statistics of the exports and the imports. The imports of merchandise in 1840—I will not stop to read all the figures, but will insert them without reading fully—were $98,000,000, in round numbers; in 1883 they were $723,000,000. The exports of domestic merchandise in 1840 were $111,000,000; in 1883, $804,000,000. The exports of domestic manufactured products in 1840 were $12,000,000; in 1883, $111,000,000. The exports of products of domestic agriculture, exclusive of raw cotton, in 1840 were $28,000,000; in 1883, $474,000,000. The export of raw cotton in 1840 was $63,000,000; in 1883, $247,000,000. The exports of domestic provisions in 1840 were $3,500,000 in round numbers; in 1883, $107,000,000.

In 1840 we had 2.818 miles of railroad; in 1883 we had 119,739 miles of railroad—railroads enough to go five times around the globe.

prosperity of all the industries, and must share the good or ill fortune of workers in every legitimate line of human effort."

I was very much interested in a speech made recently by the Senator from South Carolina (Mr. Butler) on the educational bill, and I wish to refer to it for a moment. It rejoices me to know that manufacturing dependent on patented inventions is no longer to be confined to any one section of the country, but that it is extending to every State and every Territory. There is no jealousy on this subject in the State of Connecticut. We plume ourselves upon the fact that we take out more patents in proportion to our population than any other State, showing a pre-eminence in inventive skill which has been maintained continuously since the passage of the act of 1790. But we know that a patent taken out in Oregon, in Texas, or in South Carolina adds to the productive capacity of the whole country and to its aggregate wealth, and so we have no jealousy. We know that our prosperity is to be coincident with the general prosperity. If we cannot hold our own in the manufacturing which we have heretofore carried on in the State of Connecticut, we will invent new articles which will be wanted by the people of the United States; we will anticipate their wants; we will by our inventions create a demand for the articles which we can manufacture with profit; and so I rejoice when South Carolina appears to be flourishing in the matter of manufactures dependent upon invention. The Senator said:

"Look at the matter of cotton manufacturers, which, by the way, are exempted by the State from taxation for ten years from their establishment."

I am glad to see that the same liberal policy which has prevailed from the foundation of the Government to the present time in our national capacity is beginning to find its place in the State of South Carolina.

"The increase in product in the three years is 170 per cent., and the increase in actual capacity is considerably more. This is astonishing, but it is the fact. There is no reason why the product of the South Carolina mills in 1890 should not be $27,000,000 to $30,000,000.

"The number of spindles and looms in 1880 and 1884 is given below:

	Spindles.	Looms.
1880	82,334	1,676
1884	195,112	3,652."

And so the Senator goes on to give the increase in manufactures in the State of South Carolina—the manufactured products being as follows:

1860	$8,615,195
1870	9,858,981
1880	16,738,008
1884	32,324,404

I am glad to know that this increase in manufacturing, which means increase in the applications of the patented inventions of the country, is not confined to South Carolina, but is extending through all the other Southern and Western States, as I might abundantly show if I had time.

Need I say more? Are not the figures which I have given conclusive? There are other statistics which I have showing the related value of patents to manufactures, which I will ask the liberty to have incorporated as part of my speech

Since 1840 nearly 300,000 patents have been granted, and to illustrate the progress of invention in different portions of the country attention is invited to the following table, which shows the relation between the patents granted and the population during the years 1840, 1860, and 1880:

States.	1840. One to every—	1860. One to every—	1880. One to every—
Eastern	15,133	3,269	1,642
Middle	20,834	4,049	2,066
Southern	149.349	18,363	16,491
Western	98,821	12,357	5,002

A close examination of this table will disclose that the percentage in increase in 1880 over 1840 in the Western States is more than double that of any other section.

In connection with the last table the following is introduced, showing the manufacturing statistics of the States by groups:

The following number of patents issued, manufacturing establishments, capital invested, and value of products in each State during the last fourteen years.

States.	Patents issued last fourteen years.	Number of manufacturing establishments.	Capital invested.	Value of products.
Alabama	644	2,070	$5,668,008	$13,565,504
Arkansas	409	1,202	2,953,130	6,756,159
California	4,983	5,803	51,243,786	116,218,973
Colorado	830	967	4,311,714	14,380,159
Connecticut	9,473	4,488	120,480,273	185,397,211
Delaware	520	746	15,055,822	20,514,438
Florida	177	428	3,210,680	5,046,448
Georgia	1,112	3,953	20,672,410	35,440,948
Illinois	15,125	14,549	146,632,086	414,864,673
Indiana	5,885	11,196	65,742,962	248,006,413
Iowa	4,606	6,921	33,987,886	71,045,929
Kansas	1,271	2,903	11,192,315	30,843,777
Kentucky	2,173	3,323	45,813,039	75,483,377
Louisiana	1,184	1,553	11,462,466	24,205,183
Maine	2,060	4,481	49,988,171	79,829,793
Maryland	3,250	6,787	58,742,384	105,780,563
Massachusetts	21,347	14,352	303,806,185	531,135,284
Michigan	5,203	8,873	92,930,459	150,715,025
Minnesota	1,864	3,403	31,004,811	75,065,198
Mississippi	673	1,479	4,727,600	7,518,302
Missouri	4,908	8,562	72,307,844	165,386,205
Nebraska	305	1,403	4,881,150	12,627,336
Nevada	268	184	12,323,300	2,179,626
New Hampshire	1,541	2,761	51,112,263	73,978,028
New Jersey	5,046	7,128	106,226,593	254,380,236
New York	44,089	42,739	514,346,575	1,080,696,596
North Carolina	752	3,802	13,045,639	20,095,037
Ohio	15,065	20,629	188,939,614	348,298,390
Oregon	435	1,060	6,312,056	$10,631,222
Pennsylvania	22,828	31,233	474,510,993	744,818,445
Rhode Island	2,056	2,205	75,575,943	104,163,622
South Carolina	506	2,078	11,205,894	16,738,008
Tennessee	1,443	4,326	20,092,845	37,074,886
Texas	1,730	2,956	9,245,561	20,719,928
Vermont	1,342	2,874	23,265,224	31,354,366
Virginia	1,483	5,710	26,968,990	51,780,792
West Virginia	703	2,375	13,883,390	22,887,126
Wisconsin	3,490	7,674	78,821,902	125,595,480
Grand total	195,788			

of invention. I give inventors all the credit that belongs to them, but I want to say that the manufacturers of the country, that the artisans of the country, have taken part in this wonderful development of its resources, its industries, its wealth, and its population equally with the inventors. It is the manufacturer who has furnished the capital, the enterprise to reduce these inventions to practical application; it is the cunning workmen in the factories that have applied these inventions. The invention of the telegraph was a vast conception, but it has required the manufacturer and the artisan to make that profitable to the country. If it were not for the shop hands and shops of this country there are Senators on this floor who could not go home at the close of this session, and return here at the commencement of the next session. Senators who have no very great love for this patent system are here only as the result of it.

I may be told perhaps that in my classification I have omitted the agriculturists as one of the classes of men who have contributed largely to this progress. By no means. The agriculturist has become a skilled laborer in this country. He purchases a machine. He no longer toils with the rude implements of the past. I assert, without fear of contradiction, that without patents the agriculture of the present day would be impossible, and that a large proportion of the agricultural lands of the country would be inaccessible. In 1878 we were fighting Indians and hunting buffalo in Dakota; to-day Dakota stands knocking at our doors for admission as one of the States of the Union with an alleged population of 300,000, and in the bill for its admission which is reported it is provided that the lands reserved now for school purposes, which six years ago were waste hunting-grounds, shall not be sold at less than seven dollars and a half per acre.

I do not believe the entire population capable of labor in this country could raise the cereal productions, and get the surplus to a market without the use of the patents issued to our inventors. And right here, with reference to the relation of patents to agriculture, I desire to have read a very interesting statement in an article originally printed in the Princeton Review by Professor F. A. Walker, late Superintendent of the Census. It is published in the Statistics of Agriculture, volume 3 of the Census Report, commencing on the bottom of page 29. Let the Secretary read what I have marked.

The Chief Clerk read as follows:

"Fifth. To ask what has been done mechanically to promote our agriculture is to challenge a recital of the better half of the history of American invention. Remarkable as have been the mechanical achievements of our people in the department of manufacturing industry, they have been exceeded in the production of agricultural implements and machinery, inasmuch as in this branch of invention a problem has been solved that does not present itself for solution, or only in a much easier shape, in those branches which relate to manufactures; the problem, namely, of combining strength and capability of endurance with great lightness of parts.

"In no other important class of commercial products, except the American street carriage or field wagon, are these desired qualities so wonderfully joined as in the American agricultural machines, while the special difficulty arising from the necessity of repairs on the farm, far from shops where the services of skilled mechanics could be obtained, has been met by the extension to this branch of manufacture of the principle of interchangeable parts, a principle purely American in its origin. Through the adoption of this principle by the makers of agricultural machines, a farmer in the Willamette Valley of Oregon is enabled to write to the manufacturer of his mower or reaper or thrasher, naming the part that has been lost or become broken or otherwise useless, and to receive by return mail, third class, for which the Government rate will be only two or three shillings, the lacking part, which, with a wrench and a screw driver, he can fit into its proper place in fifteen minutes.

"All the agricultural machines of to-day are not originally of American invention, although most of them are, in every patentable feature; but I am not aware that there is at present in extensive use one which does not owe it to American ingenuity that it can be popularly used. Without the improvements it has received here, the best of foreign inventions in this department of machinery would have remained toys for exhibition at agricultural fairs or machines only to be employed on large estates under favorable conditions.

"But more even than the ingenuity of inventors and manufacturers has been required to give to agricultural machinery the wide introduction and the marvelously successful applications it has had in the cultivation of our staple crops East and West. 'Experienced mechanicians,' says Professor Hearn, 'assert that, notwithstanding the progress of machinery in culture, there is probably as much sound practical, labor saving invention and machinery unused as there is used, and that it is unused solely in consequence of the ignorance and incompetency of the work people.' This remark, which is perfectly true of England and the force of which would have to be multiplied fourfold in application to the peasantry of France or Austria, utterly fails of significance if applied to the United States. It is because mechanical insight and aptitude, in the degree respecting which the term "mechanical genius" may properly be used, are found throughout the mass of the American people that these products of invention and skill have been made of service on petty farms all over our land, and in the most remote districts. Lack of mechanical insight and aptitude, in the full degree requisite for the economical use and care of delicate and complicated machinery, is almost unknown among our native northern people. Not one in ten but has the mechanical sense and skill necessary for the purpose.

"But it has not been through the invention and wide application of agricultural machinery alone that the peculiar and extraordinary mechanical genius of our people has increased our national capacity for agricultural production. In what we may call the daily commonplace use of this faculty, throughout what may be termed the pioneer period, and in a diminishing degree through each successive stage of settlement and industrial development, the American farmer has derived from this source an advantage beyond estimation in dealing with the perpetually varying exigencies of the occupation and cultivation of the soil."

Mr. Platt: Imagine, if you can, how we should reach our agricultural regions, the great wheat fields of the West, without railroads; and I may say here that a railroad, from the steel rail to the top of the smoke-stack, from its locomotive head-light to the signal-lantern on the platform of the last car, is but one aggregation of patents. Think of the crops raised without improved plows, without seeders, without cultivators, without mowers, without harvesters,

Table showing the number of patents issued in each decade from 1840 to 1880, inclusive, and in the year 1883 in each State, and showing the relation between the number of patents granted and population.

	1840.		1860.		1870.		1880.		1883.	
	Patents issued.	One to every—	Patents issued.	One to every—	Patents issued.	One to every—	Patents issued.	One to every—	Patents issued.	One to every—
Alabama	6	190,252	8	249,811	25	47,922	29	34,400	62	20,366	77	16,396
Arkansas			2	206,897	5	87,000	13	37,300	44	18,240	39	13,672
California					40	7,795	243	2,300	349	2,491	695	1,456
Colorado									24	8,110	119	3,653
Connecticut	42	12,477	45	27,724	235	11,958	667	900	610	2,020	883	705
Delaware	4	39,085	4	22,983	8	5,064	46	5,717	23	7,376	26	4,079
Florida						14,042	10	18,775	15	17,823	24	11,226
Georgia	6	348,698	6	1,319,020	21	14,761	73	10,230	77	10,987	118	10,410
Illinois	1	476,183	14	605,819	241	7,103	871	2,916	963	3,263	1,782	1,717
Indiana	3	228,522	21	479,067	96	13,780	263	4,277	339	5,510	712	2,772
Iowa			1	192,214	20	13,428	225	5,387	295	5,700	443	3,650
Kansas					3	20,726	40	9,110	96	10,574	186	5,270
Kentucky	6	329,979	6	432,800	42	27,816	125	8,758	170	9,539	298	7,231
Louisiana			6	86,230	23	11,238	95	7,655	160	14,243	90	11,749
Maine	10	50,179	10	58,316	73	8,606	197	5,193	103	6,425	193	3,545
Maryland	26	48,077	16	82,990	91	10,913	240	4,254	229	4,681	289	3,808
Massachusetts	78	69,837	130	46,267	456	2,700	1,396	1,961	1,393	1,973	2,173	890
Michigan	9	50,556	3	133,554	74	10,123	383	8,091	450	3,636	727	2,251
Minnesota					7	24,575	53	8,302	114	6,949	310	3,717
Mississippi			3	264,283	45	17,585	48	17,333	59	20,015	84	22,186
Missouri		437,000	4	176,841	75	18,780	248	8,435	327	8,940	628	4,469
Nebraska							12	10,250	31	14,594	37	8,200
Nevada							21	3,128	24	3,500	28	3,702
New Hampshire	10	29,657	15	21,199	62	5,246	102	3,121	111	3,125	139	2,496
New Jersey	6	92,217	21	23,312	133	8,053	406	1,827	518	2,180	1,066	1,061
New York	131	18,533	209	14,889	1,239	8,132	5,054	1,450	4,902	1,814	4,259	1,166
North Carolina	2	278,708	2	280,679	28	26,179	51	21,000	56	38,898	67	16,088
Ohio	22	47,543	71	97,891	341	9,708	905	2,935	917	3,466	1,604	1,993
Oregon					1	52,495	23	4,000	22	7,943	76	2,299
Pennsylvania	57	31,024	209	11,061	494	8,863	1,543	2,384	1,324	3,234	2,168	1,975
Rhode Island	9	12,092	9	16,393	71	2,459	184	1,181	205	1,345	327	845
South Carolina	2	297,199	4	167,126	25	28,148	26	27,139	59	25,538	147	21,192
Tennessee	4	267,302	7	148,245	80	27,745	104	12,100	82	18,810	124	13,438
Texas			2	106,296	22	26,270	52	15,742	147	10,833	208	7,692
Vermont	11	26,940	11	28,556	82	5,082	111	8,000	76	4,373	109	3,048
Virginia	6	208,632	14	78,981	100	45,962	168	11,362	99	15,280	128	12,398
West Virginia							42	30,524	52	31,863	82	7,542
Wisconsin			3	101,797	61	37,959	227	4,646	276	4,766	394	3,338
Territories, United States Army, United States Navy, and foreign countries	3		34		98		688		948		1,610	

1880.—States (Territories not included).	Number of establishments.	Capital invested.	Average number of hands employed.	Total amount of wages paid during the year.	Value of materials.	Value of products.
Eastern	253,268	$490,392,449	817,806	$181,420,071	$528,210,629	$887,026,642
Middle	85,476	898,511,906	945,825	266,432,261	1,058,197,879	1,680,327,772
Southern	20,266	146,206,419	187,143	43,323,908	163,606,942	261,006,431
Western	93,847	686,169,022	480,976	221,694,500	905,255,572	1,447,210,267
	200,883	2,220,229,676	2,081,844	753,060,740	2,705,361,022	4,273,471,112
Ratio of labor in each section is as follows:	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Eastern	12½	22½	39½	24	19½	20¾
Middle	22½	40	45½	35½	39	39¼
Southern	7½	6½	9	4	6	6
Western	47½	31	23	29½	35½	34

I have the number of patents issued during the last fourteen years for each State in the Union, the number of manufacturing establishments in each State, the capital invested, and the value of manufactured products in each State. It will be seen that the capital invested and the manufactured products bear a close relation and proportion to the number of patents issued in those States.

I have also a table, prepared by the Patent Office, showing the number of Patents issued in the years 1840, 1850, 1860, 1870, 1880, and 1883 in each State, and showing the number so issued in proportion to the population in each State, showing the growth of the patent system along the lines where the manufacturing growth of the country has taken place, and some other tables further illustrating the close relation of inventive skill to manufacturing, which I submit to the Senate. [For tables see above.]

Is it not apparent that every department of business, every pursuit of organized life, has been fed, nourished, and enabled to keep step in this wonderful march of progress by the patented inventions of the age?

Now, I want to say that three classes of men have made this possible—first, the inventors; second, the manufacturers; third, the skilled laborers; and by skilled laborers I mean not only the operatives, the mechanics who make the labor-saving machines, but the men who are educated to comprehend the operation of machines and processes.

I know that it is often acknowledged that the wonderful growth of the country to which I have adverted is the result

without thrashing machines! Think of the crops hauled to market by horses! Think, if it be possible, of the wheat converted into flour without patented milling processes! And say what proportion of profitable agriculture in this country is not due directly to patents and to the patent system of the country. The truth is, and there is no avoiding it, that you cannot disconnect in this country invention, manufactures, and agriculture. The triumph and the success of the one is the triumph and the success of all. They are interdependent, coequal factors as it were in producing our prosperity and our happiness; and so with regard to the other industries of the country patents are directly connected with them all and absolutely necessary to their successful pursuit. I will not stop to enlarge. I take coal mining, and ask you to imagine and tell me whether it can be carried on except by the use of patented inventions. Then gold and silver mining, furnishing one-half of the precious metals produced in the whole world, iron producing, and if there be any other productive enterprise or occupation take away from it the factor of invention and tell me how much the diminished production will be.

Here I want to say one word with relation to the effect of patents and patented inventions upon the exporting capacity of the country. In the present state of the world's trade you must land your wheat, your corn, your cotton, and your other agricultural productions in Liverpool for as little money as the wheat and corn and cotton of any other part of the world can be landed there; you must compete with all systems of labor and production; and how is it that you are enabled to lay down your corn, your cotton, your wheat, your flour, your provisions, in Liverpool as cheap as the wheat, the corn, the flour, the provisions, of other countries can be sold there? It is simply because by the use of patented inventions you are able to produce them at a cost far less than they would have been produced under the old system, and that, too, while paying the laborer engaged in producing them much higher wages than are paid in any other land. That nation which gets most of the world's trade is to be the first power of the globe. Both patriotism and the interests of humanity impel us to say that the United States must have it. How is it to obtain it? It is to be obtained only by encouraging the inventive genius of our citizens by protecting the patent system of the country and all that is involved and comprehended in that system; and as we stimulate the inventive faculty and protect the patent system, we shall steadily reduce the cost of production in this country until we are able to compete with the world, no matter what may be its system of labor.

One striking fact cannot be gainsaid or overlooked—each ten years of our last half century has shown a marked reduction in the cost of all products and a marked increase in the compensation of labor, and such diminished cost of production and increased compensation of labor has been greater in the United States than in any other country.

The day when we shall have more of the world's trade than any other country is not so far distant as some may imagine. I want to read an extract from Mr. Gladstone's Gleanings of Past Years, in chapter 8, "Kin beyond Sea":

"I do not speak of political controversies between them and us, which are happily, as I trust, at an end. I do not speak of the vast contribution which, from year to year, through the operations of a colossal trade, each makes to the wealth and comfort of the other—"

Speaking of England and of the United States—

"nor of the friendly controversy, which in its own place it might be well to raise, between the leanings of America to protectionism, and the more daring reliance of the old country upon free and unrestricted intercourse with all the world; nor of the menace which, in the prospective development of her resources, America offers to the commercial pre-eminence of England. On this subject I will only say that it is she alone who, at the coming time, can, and probably will, wrest from us that commercial primacy. We have no title; I have no inclination to murmur at the prospect. If she acquires it, she will make the acquisition by the right of the strongest; but in this instance the strongest means the best. She will probably become what we are now, the head servant in the great household of the world, the employer of all employed, because her service will be the most and ablest; we have no more title against her than Venice, or Genoa, or Holland has had against us. One great duty is entailed upon us, which we unfortunately neglect, the duty of preparing by a resolute and sturdy effort to reduce our public burdens in preparation for a day when we shall probably have less capacity than we have now to bear them."

Again in the same article:

"The development which the Republic has effected has been unexampled in its rapidity and force. While other countries have doubled, or at most trebled, their population, she has risen during one single century of freedom, in round numbers, from two millions to forty-five. As to riches, it is reasonable to establish from the decennial stages of the progress thus far achieved a series for the future; and, reckoning upon this basis, I suppose that the very next census, in the year 1880, will exhibit her to the world as certainly the wealthiest of all the nations. The huge figure of a thousand millions sterling, which may be taken roundly as the annual income of the United Kingdom, has been reached at a surprising rate; a rate which may perhaps be best expressed by saying that if we could have started forty or fifty years ago from zero, at the rate of our recent annual increment we should now have reached our present position. But while we have been advancing with this portentous rapidity America is passing us by as if in a canter. . . . There can hardly be a doubt as between the America and the England of the future that the daughter at some no very distant time will, whether fairer or less fair, be unquestionably stronger than the mother."

And in this connection I wish to read a single sentence from Mulhall's Progress of the World:

"The increase of wealth—"

Speaking of the United States—

"since 1850 would suffice to buy up the whole German Empire, with its farms, cities, banks, shipping, manufactures, etc. The annual accumulation has been £165,000,000, and therefore each decade adds more to the wealth of the United States than the capital value of Italy or Spain. Riches are more evenly divided than in Europe; few are very rich, fewer still indigent."

But this supremacy, this primacy of the world, is only to be reached through the field of invention. To those who believe that the center of the world's trade is to be moved from England to America in the near future, that its exchanges are to be moved from Threadneedle street to Wall street, I commend the careful, watchful guardianship of the patent system of the United States.

Now, I desire to speak a little about our productive capacity as enhanced by patents. We are a nation of 50,000,000 people, but we have the productive capacity of many more millions, how many more no man can estimate. Coal and water are now performing the work of human hands. What agents will perform them in the near future it is impossible to tell. The steam power used in the manufactories of the United States, by the census of 1880, was equal to 2,183,488 horse power; the water power was equal to 1,225,379 horse-power; making in all the horse power of the United States 3,408,867. Counting one horse power to be equal to that of six men, we have in the power used in the driving of our factories alone in this country the equivalent of the power of 20,453,202 men. The steam power used in driving our factories, not including the water power, is equivalent to the labor of 13,100,928 men; and of our 50,000,000 people only 35 per cent. are supposed to be capable of labor; in round numbers 17,500,000 laborers, persons capable of pursuing gainful vocations, in the country; and yet it would nearly take these 17,500,000 men to furnish the force that is exercised by steam in driving the engines of our factories, the wheels, the spindles, and the machinery of this country; and we do not begin to touch even then upon the saving of power by the use of the machines which are manufactured in these factories.

Take the capacity of locomotive engines as compared with the capacity of horses. I will read a single sentence from the argument of Mr. Coffin, a distinguished journalist of Boston, before a select committee of the House of Representatives in the Forty-fifth Congress, third session, relative to the causes of the general depression of labor and business in the United States. He says:

"I come now to railway transportation. The Massachusetts railway reports for 1876 show 1,030 locomotives at work. One of our ablest engineers, Mr. Edward Appleton, has set himself to see what those locomotives would do when compared with the use of horses on common roads, and he estimates (after throwing out the locomotives that are used on tracks that are being repaired and in machine shops) 682 locomotives in use, and that the work performed by them would be equal to 1,519,496 horses on common roads. Taking his formula and applying it to the locomotives of the United States, as given in Poor's Manual, we find that the locomotives in the entire country are doing the work of 29,676,960 horses on common roads."

But you only enter the vestibule of increased capacity by these figures. Remember that eight-tenths of the manufacturing of the country is dependent on patented processes. Take the statement cited the other day by the Senator from Florida [Mr. Call], in which he quotes from Mulhall's Progress of the World, a book from which I have already quoted, as to the capacity of the sewing machine:

"In effect, the adoption of machinery and steam has given mankind an accession of power beyond calculation. The United States, for example, make a million sewing machines yearly, which can do as much work as formerly required 12,000,000 women working by hand. A single shoe factory in Massachusetts turns out as many pairs of boots as 30,000 boot makers in Paris."

Mulhall here gives the total horse power in comparison with steam as 13,071,000, the horse power of the world dependent upon the use of steam, equivalent to about 78,000,000 men.

Take the loom and see what it has done in adding to the productive capacity of the country. I read again from Coffin's testimony before the Congressional committee. He says:

"In those days the industries were carried on in the household. There was no industry for females except that of the spinning wheel and the loom. I had the curiosity to ascertain just what a spinner could do in a day, and I sent up to New Hampshire to a sister of mine who used to be an expert spinner, knowing that she had a spinning wheel and some rolls, and I had the exact measurement of the distance which she walked in spinning with a large wheel A day's work of ten hours would enable her to spin 3·8 miles of thread, and she would walk nearly five miles in doing it. Now, in one of our manufactories you will see a girl of 15 minding a machine that spins 2,100 miles of thread in a day—a thread that would reach from Washington to California. In those days the woman who commenced with the spinning wheel and the loom to get her fitting out when about to get married would have to spend many weary days in making her sheets. To-day she obtains them at 75 cents apiece. In those days there was no industry that females could turn their hands to except the spinning wheel and the loom. They were utterly cut off from doing anything else except working in the field with the men."

Take the figures which I have given of the wool production and consumption of this country. In 1880 the wool grown was 290,000,000 pounds; that imported was 70,575,478 pounds. We exported 4,074,517 pounds, which left for home consumption in the United States 356,500,961 pounds of wool. Now, imagine for a moment what kind of a figure the mothers and daughters of the land would make in carding it with the old hand cards, or spinning it with the old spinning wheel, or weaving it with the old hand loom. Take the single matter of cleaning cotton. I read again from Coffin's testimony:

"Take another illustration. Under the old process of cleaning cotton, before the invention of the Whitney gin, a man could clean four pounds a day. The gins now in use clean 4,000 pounds a day. The cotton crop of this country last year" (this was in 1879, it is much larger now) "was estimated at 4,700,000 bales. It probably exceeded that. That would be 2,021,000,000 pounds. Under the old way it would have required 505,000,000 days' work at $1 per day (that is, $505,000,000) to clean cotton, a work which is done at present by 1,614 men working 313 days in the year, and costing not over $500,000."

Take the matter of manufacturing cotton, all of which is dependent upon patented inventions. The cotton mills of the world make six million miles of cotton cloth every year, which would furnish a band to the moon seventy-five feet wide.

We need not go further with figures to show how inventions increase the productive capacity of the country. The whole laboring population of the country could not care for its cotton and wool. I quote again from Mr. Coffin:

"If you visit Garsed's manufactory in Philadelphia, you will find his engine doing with seven tons of coal the work of seventy thousand men. If we reckon seven tons of coal as costing $21, and the labor of seventy thousand men at $1 a day, then it is $21 as against $70,000 of expenditure saved in muscular effort. Does it throw men out of employment? Does it not liberate them from muscular toil? Does it not leave them to do something better and higher? Instead of employing their muscles they employ their brains."

Whenever a machine is invented that does the work of ten men with one attendant, nine men are released from that occupation in which they have theretofore engaged to engage in other productive operation. The men so released do not remain idle nor do they descend in the grade of labor.

I know the argument is often used that inventions are opposed to the labor interest of the country. It is not true. There is a redistribution of labor whenever a new labor saving machine is invented, but there is no destruction of labor. There is no degradation of labor in invention. The man released from a particular kind of labor by the introduction of a labor saving machine does not go down in the scale and grade of labor, but he ascends. He engages in some higher employment, in some more productive vocation, for patents elevate the laborer. New inventions open new fields of labor. Take printing, take photography, take telegraphy, take gas making, take steam transportation—take all these fields of labor, which have been positively created out of nothing by invention, and you will find that the man released from labor in some old occupation by the introduction of machinery which performs his work enters some of these new vocations with increased compensation for his labor.

Again, the laborer who lives and breathes the air of invention produces more, man for man, than he who does not live in such an atmosphere, for patents are educators. Education, as was well remarked by the Senator from South Carolina (Mr. Butler) in a recent speech, is something more than book learning. It is knowledge in its widest sense. It is information; and for one I believe that the man who learns to operate a complicated machine acquires education of as much real value to himself and the race as the man who learns to conjugate Greek verbs. The man is a wiser man, a nobler man, who can make or operate a complicated machine than the man who cannot. There is an education of the college. There is also an education of the factory and the field. We may not despise or neglect either. The man who is learned in the classics may not call him ignorant who without knowledge of the languages yet understands the practical application of mechanical principles or the improved processes of agricultural production

What I have said is as true of the agricultural as of the mechanical. The farm hand who has become familiar with all the patented inventions relating to agriculture, with the machines which are to-day used in agricultural pursuits, can produce more, man for man, than the man living in Canada, who has no conception of such a machine, or the power to comprehend it, or the ability to use it. We may go further. Compare the intelligent farm hand of the Western prairies with the peon of Mexico or the serf of Russia, and tell me which has the most productive capacity.

I desire once more to cite from Mr. Mulhall on this point some very interesting statistics, and I read from him rather than from American authors, because I desire to take the word of an Englishman upon these subjects. He has on page 55 a table showing the number of operatives in factories, together with the product of those factories and the product per operative in the United Kingdom, France, Germany, Russia, Austria, the Low Countries, Spain and Portugal, Italy, Scandinavia, the United States, and the British colonies. From this it appears that the factory operative in the United States produces, according to these statistics, £312 value per annum, which is about $1,560 per annum. The operative in Great Britain produces £224 value per annum, showing that the operatives in the manufactories of the United States produce about 40 per cent. more in value than the operatives in the manufactories of Great Britain. In France the excess of production in favor of the American operative is still larger. In Germany the value produced per operative is only £103 per annum, as against £312 for the operative in the United States; and, averaging all Europe, the operative in the United States produces just double in value to the operative in Europe. The full figures are:

United Kingdom	£224
France	220
Germany	103
Russia	106
Austria	120
Low Countries	100
Spain and Portugal	119
Italy	108
Scandinavia	90
All Europe	156
United States	312

Why this difference, except because the operative of the United States has been educated by the patent system and by a knowledge of the patented inventions of the country?

I have already given the statistics of our patents since 1836. The total number of the issue which will be made on the 8th of April is 296,715. I desire to put in here a table showing the patents issued in foreign countries:

English patents, total to December 31, 1883	140,047
English patents for year 1883	6,000
German patents, total to December 31, 1883	26,084
German patents for year 1883	4,848
French patents, total to April 30, 1883	172,451
French patents for year 1882 (1883 not received)	6,269
Italian patents, total to December 31, 1882, about	13,560
Italian patents, yearly	1,250
Belgian patents, total to December 31, 1882	60,043
Belgian patents for year 1882	3,400
Hungarian patents, total to December 31, 1882	20,434
Hungarian patents for year 1882	2,377
Austrian patents, total from 1853 to December 31, 1882, inclusive	29,310
Austrian patents for year 1882	2,377

Thus it will be seen that under the English patent system, which commenced in 1624, the total number of patents issued up to December 31, 1883, was only 140,047. France, whose patent system commenced in 1791, issued up to April 30, 1883, 172,451 patents. In the other countries given, the number of patents issued is very much less than those I have referred to.

The factory in this country has become the school of the useful arts. Every valuable patent builds a factory, and every factory produces scores of patents; and so the invention and the practical education of our people go on.

I desire for a few moments to consider the question of property in patents. There are some people, I am sorry to say, who have very little regard for this property—for the property right of the inventor and patentee. I think I will show that it is as sacred a property and as much entitled to the protection of the Government as any other species of property. Nay, more, I think I will show that it is a property which stands on a higher plane, and which, if there is any distinction between property, is of a higher character and

order than any other property in this land. I wish here to quote from the most recent and I think the best treatise on patents, published by a citizen of my own State, Mr. Albert H. Walker, of Hartford, Conn., what he says as to the right of property in patents. I will ask the Secretary to read it.

The Chief Clerk read as follows:

"SEC. 152. The right of property which an inventor has in his invention is excelled in point of dignity by no other property right whatever. It is equaled in point of dignity only by the rights which authors have in their copyrighted books. The inventor is not the pampered favorite or beneficiary of the Government or of the nation. The benefits which he confers are greater than those which he receives. He does not cringe at the feet of power nor secure from authority an unbought privilege. He walks everywhere erect, and scatters abroad the knowledge which he created. He confers upon mankind a new means of lessening toil or of increasing comfort, and what he gives cannot be destroyed by use nor lost by misfortune. It is henceforth an indestructible heritage of posterity. On the other hand, he receives from the Government nothing which costs the Government or the people a dollar or a sacrifice. He receives nothing but a contract which provides that for a limited time he may exclusively enjoy his own. Compared with those who acquire property by devise or inheritance, compared with those who acquire property by gift or marriage, compared with those who acquire property by profits on sales or by interest on money, the man who acquires property in inventions by creating things unknown before occupies a position of superior dignity. Even the man who creates value by manual labor, though he rises in dignity above the heir, the donee, the merchant, and the money lender, falls in dignity below the author and the inventor. The inventor of the reaper is entitled to greater honor than his father who used the grain cradle, and the inventor of the grain cradle is entitled to greater honor than his ancestor who for a hundred generations had used the sickle. Side by side stand the inventor and the author. Their labor is the most dignified and the most honorable of all labor, and the resulting property is most perfectly theirs.

"Lord Bacon gave the weight of his opinion to views somewhat similar to the foregoing. The following is a translation of one of his Latin prragraphs:

"'The introduction of great inventions appears one of the most distinguished of human actions, and the ancients so considered it; for they assigned divine honors to the authors of inventions, but only heroic honors to those who displayed civil merit (such as the founders of cities and empires, legislators, the deliverers of their country from lasting misfortune, the quellers of tyrants, and the like). And if any one rightly compare them, he will find the judgment of antiquity to be correct; for the benefits derived from inventions may extend to mankind in general, but civil benefits to particular lands alone; the latter, moreover, last but for a time, the former forever.'"—*Walker on Patents*, 102, 103.

I know the author will excuse me if I endeavor to supplement his very terse and undeniable statement of the character and of the dignity of this property right with some ideas of my own. This property in patents is a property which contains within itself the principle of the reproduction of property, and that is a characteristic which attaches to no other species of property. Every patent has in it the germ of a new patent, which in turn is property. Like that marvelous creation of God, "the tree, in the which is the fruit of a tree yielding seed," every patented invention contains the fruit of an invention yielding seed. For instance, the telegraph generated the telephone, and other motors are to be the progeny of the steam engine. The children of the steam engine are already born that shall grow up to perform their work more easily, more expeditiously, more cheaply than the parent invention.

The most significant word in the grant of a patent is that one word "improvement." Letters patent state that, "Whereas A. B. has discovered a new and useful improvement," etc. Every patent is an improvement in more senses than one. It is an improvement on the particular machine or process to which it has reference, but it is an improvement in a broader and more far reaching sense. It is an improvement of every man who uses it, in knowledge, in comfort, in strength, in power, in beneficence. It is, in a word, an improvement of humanity itself. It is well that that technical word is used in every grant of letters patent. It is property of a high character in that it is a property which springs from the human brain. Processes of the brain are at once the basis and measure of all values. I hear it said that value is created and is measured by labor, by muscular toil; that the intrinsic value of the gold dollar is what it costs the average man to dig it out of the earth. But value has a higher author than muscular labor. Man in savagery produces no wealth; he neither creates nor acquires property. The higher the citizen ascends in the subtle processes of thought, the more wealth will be found in the country. The higher a race ascends in intellectual capacity, in the faculty of contrivance, in inventive skill and genius, the richer will the race be. Nature is one vast storehouse of wealth, but it is a locked storehouse, and the human brain alone can unlock it. Invention is the magic key. Men seek gold in the bowels of the earth, but it lies in the air, in light, in the gases, in electricity. It needs no enchanter's wand, no talismanic words to set it free—only the processes of thought.

Men in the olden time sought some substance which should turn all the baser metals to gold, so they imagined, and they spent weary lives in searching for the philosopher's stone. They narrowly missed what they sought. There was a substance which turns all things to wealth, but it lay within their own brain. That gray matter of the brain is mightier than the fabled philosopher's stone. The processes of thought which are going on within the cells of that matter alone produce wealth, and power, and greatness. Men sailed to the westward to find an El Dorado. They found it. The land was full of wealth; but they lacked the eyes to see the riches and the power to conquer and appropriate it. They sought an outward kingdom, but the kingdom of wealth and power lay all undeveloped within them.

Banish wealth, if you please, from this country, transfer all the available wealth of the land to Russia, make every man bankrupt, and leave the means of but six months' subsistence, and in a single generation we will reproduce this wealth of which we are so proud to-day. It would be simply the outcome of the human brain—simply wringing from nature her secrets by the inventive faculty of man.

Few men, I believe, have thought of the actual money-value of patents. The mind cannot measure it. There are few data from which it can be estimated. We may perhaps gather some idea of the money value of patents by seeing what they have cost inventors. The unexpired patents to-day are 235,400, a somewhat larger number than I had supposed when I made the calculation which I am about to submit. I had taken 230,000 as the number of outstanding patents, and they have cost in Government fees $8,000,000; that is to say, the inventors have paid into the Treasury of the United States to obtain those patents $8,000,000. If you allow attorneys' fees at $50 each, there is $11,500,000 more. If you put the time in experimenting and the expense of making models at $100 more, and that is vastly too small, it will be $23,000 000 more. So that you will have $42,000,000 as the cost of the title deeds which have been given to the inventors of this country that are now in force. But that is no measure of value. That is the first cost; that is the cost of obtaining. I know that it is difficult to put any average value upon patents; I know that some of them are worth millions, and some of them are worth nothing, but I think it would be safe to say that they are worth $500 on an average; and, if so, we have as the value of the patented inventions upon that basis, not reckoning cost, $115,000,000, the actual salable value. Others would put the average value of patents very much higher.

But this, after all, is no way to measure the value of patents. If we measure them by what they create, by what they save in cost, by what they add to production, by their multiplication of values, then the sum total is simply incalculable.

Let me give you an illustration or two of the saving of patents. I take perhaps as the most marked instance of the saving made by the use of patented inventions the Bessemer steel plant, and I want to say right here that I do not like to have it said that this is the invention of a foreigner alone. I want Americans and American inventors to have their rightful share of credit for this invention. The article known as Bessemer steel was an American invention. It was made by William Kelly, an iron-master of Eddyville, Ky., and in 1856 and 1857 the Patent Office, in an interference between him and Bessemer, decided that Kelly was the prior inventor. B. F. Mushet, of England, finally added a further improvement, which rendered it practicable. The first rail of it was laid on the Midland Railroad in England, 1857, merely as an experiment. The first works were established here in 1864–65 at Wyandotte under the Kelly patent, and in 1865 by Burden at Troy. The Kelly, Bessemer, and Mushet patents were consolidated in 1866, and work began in 1868. Good quality was not produced until 1870, when the company producing it failed.

So much for the history of the Bessemer invention. In 1868 the average price of steel rails was $165 per ton. The price since the commencement of 1884 is $34 per ton. The production of steel rails in 1883 was 1,295,740 tons. The same quantity made in 1868 would have cost more than they cost in 1884 by $168,446,200. That is the saving of a single year as the result of this invention.

But when we have thus considered the saving in the cost of production we have just begun to consider the saving which is effected by this patent. The entire transportation question of the country has been affected by it. The life of a Bessemer steel rail is double the life of an iron rail; it is more than double, and it is capable of very much harder usage. Now take a single fact as suggesting the saving, aside from that of cost of the production of the steel rail, which has been effected by this patent. In 1868 the freight charge per bushel from Chicago to New York was by lake and canal 25·3 cents, by all rail 42·6 cents. In 1884 by lake and canal it is 9 cents only and by all rail 17 cents only. Now take the 119,000 miles of railroads in the United States which are used in the transportation of merchandise. Apply that fact to the reduction of the cost of transportation, a large portion of which has resulted directly from the use of the Bessemer steel rail, and tell me if you can estimate, see if you can find the figures which will represent the saving to this nation by reason of the use of this one patented invention.

Let me take another illustration; and I do this because I hear that the barbed-wire patent has oppressed people; I hear that people who use it are unwilling to pay any royalty for the use of it, and so I cite this illustration to show the saving effected by patents. There have been made and sold from 1874 to 1882, inclusive, of barbed wire for fencing 459,805,000 pounds, which make equal to 1,379,806 miles of post-and-rail fence or 110,384,480 rods. An old board-and-post fence costs $1 per rod, and the barbed-wire fence costs 50 cents per rod. Hence the actual saving to farmers already by this one invention is $55,192,240.

The total amount of fencing in the United States is estimated at 1,619,195,428 rods. At $1 per rod this would amount to as many dollars; whereas if we had had this invention and could have built all these fences of barbed wire at 50 cents a rod, it would have saved the farmers of this country the enormous value of $809,597,714. I take as my authority for the cost of fencing, an agricultural paper published in Iowa, the *Iowa Homestead*, and in this estimate nothing is included of the saving in the repairs of fences.

Take an illustration which has reference to the Patent Office, representing a smaller saving, but no less forcible. Before the establishment of photolithography was applied to the production of copies of drawings in the Patent Office they were produced by tracing, costing from one to ten dollars each, and the party ordering them from three to twenty-five dollars each. By this process they now cost the Government about one cent each, and are sold to litigants and inventors for ten cents, copies of which are constantly demanded by the courts in infringement and other patent cases. I merely speak of that as illustrative of the saving resulting from the use of patented machines.

This leads me to speak of the value of patents as measured by their effect in enhancing the value of their products. Here we have no data, and every one must judge from his own standpoint and from his own opinion as to how much has been added to the wealth of this country which would not have been added to it except for our inventions and our patent system. How much has been added to the value of land which otherwise would not have been fenced, how much to the value of urban property consequent upon the improvement and development of farms; how many cities owe their existence to the production of the Bessemer steel rail; how much, to come home to our own city, of the $5 per square foot of land near the outskirts of Washington is due to patented inventions? These are suggestive inquiries. For my part, I believe that two-thirds of the aggregate wealth of the United States is due to patented inventions. Two-thirds of the $43,000,000,000 which represents the aggregate wealth of the United States, in my judgment, rests solely upon the inventions, past and present, of this country. The only way to test the opinion is by imagining the effect upon values which would follow a prohibition of the use of patented inventions.

Take the expired and unexpired patents; prohibit the application of steam to the creation of power; prohibit the use of patents relating to agriculture and the production of the cereals and of cotton; prohibit the use of the inventions relating to electricity and all its uses; prohibit the use of inventions relating to printing, and tell me how much you have subtracted from the value of the property of this country. Tell me what the property of the country would be worth with such a prohibition. Then banish the knowledge of them, and tell me how this wealth is to be reproduced.

I would gladly speak here of the addition to our comforts and our enjoyments by the use of patented inventions, but I forbear. If we can conceive a situation in which we should live in a home in the building or fitting up of which no patent was employed; eat our family meal in the provision or preparation of which there was no invention; be clothed in apparel into the making of which no patent entered; ride to our business in a conveyance in the construction of which all patents were prohibitory; read only such books and papers as were produced without the intervention of patented machinery, we may realize partially how much of our social and domestic happiness is derived from patents.

I wish in this connection to submit, without reading, the number of patents granted, classified as relating to different arts, occupations, and branches of industry:

F.

	Patents.
APPAREL.	
Apparel	2,417
Crinoline and corsets	969
Jewelry	653
Toilet	362
Umbrellas and fans	893
Boots and shoes	5,060
ELECTRICAL.	
Electricity	5,872

In the various branches of electrical research the applications for patents now average about 250 a month.

	Patents.
FARM, AGRICULTURAL, AND TILLING.	
Harrows and diggers	2,421
Plows	6,686
Seeding and planting—seeders and planters	3,568
Gathering—harvesters	6,606
Products, field and farm—dairy appliances	2,429
Fences	2,888
Mills and thrashing	6,740
Presses	2,708
Culture—garden and orchard	682
Care of live stock	1,232
TEXTILE MANUFACTURES.	
Carding	647
Cloth finishing	268
Cordage	589
Knitting and netting	753
Silk	350
Spinning	1,023
Weaving	2,372
METAL WORKING MACHINES.	
Examiner Jayne's entire class	10,204
Farriery	746
Grinding and polishing	1,425
Founding	1,131
Tempering, etc	263
Tools	1,662
Nut and bolt locks	734
Sheet metal ware making	365
STEAM ENGINEERING.	
Air and gas engines	356
Fluid pressure regulators	398
Injectors and ejectors	240
Steam pumps	174
Steam boilers	2,407
Steam engines	5,111
Steam-boiler furnaces	2,333
Steam valves	1,533
Steam-water elevators	46
METALLURGY.	
Coating with metal	244
Metallurgy	2,418
RAILWAYS.	
Railways	3,504
Railway cars	6,505
LEATHER.	
Chemical and mechanical treatment of hides, skins, and leather	1,219
ENGINEERING.	
Bridges	694
Excavating	1,143
Hydraulic engineering	622
Masonry	544
Roofing	508
Fire escapes	884
Artesian and oil wells	500
HOUSEHOLD—THE HOUSE.	
Bread and cracker machines	440
Chairs	1,585
Furniture	1,943
Laundry	4,993
Beds	2,153
Household articles	1,589
Curtain fixtures	913
Vegetables cutters and crushers	405
HYDRAULICS AND PNEUMATICS.	
Baths and closets	1,207
Fire engines	567
Hydraulic motors	1,456
Pneumatics	2,742
Pumps	3,156
Water distribution	3,769
CALORIFICS.	
Driers	1,342
Lamps and gas fitting	5,254
Stoves and furnaces	8,238

We protect all our personal property by patents, we lock it up with patented locks, and if anybody breaks through and steals our treasures we overtake the thief by a patented telegraph. We defend our national honor by patents. We heard only yesterday that an unfortunate riot occurred in one of our principal cities. It was the telegraph that summoned the troops of the State to Cincinnati; it was that subtile force, so intangible, impalpable, invisible, that we scarcely know whether it is material or spiritual, which the inventive genius of man has harnessed to do his business, which at an instant's time summoned soldiers from all sections of Ohio to the defense of Cincinnati.

Take another instance: Many believe, I fully believe, that Ericsson, a foreigner, but I think an American citizen, by a single invention changed the whole theory of naval architecture, the naval warfare of the world, and prevented this country from dismemberment and disunion. That single invention, originating in the brain of an humble individual, whose invention was not favored by the Government, and who was never to my knowledge compensated by the Government, changed the history of the whole world. Consider this one instance of the effect of patents, and tell me what is the value of patented inventions, and what they have added to the value of property in this country.

A distinguished member of the Army told me within a short time that the only reliance of this country in case of war was upon the inventive genius of its people, that it had no navy, that it had no sufficient army, that it could only defend itself by a special exercise of the inventive faculty of its citizens in calling into immediate use and power new implements of warfare.

Is not this vast system of property worth protecting? Does not the patent system attain a dignity which entitles it to fair and generous treatment? Is it not large enough to be independent?

I have heard it said that we should have all these inventions any way; that men would have invented without regard to the encouragement which was given to them by our patent laws; that if this exclusive use of their inventions had not been secured to them for a term of years, that if their property in patents was not protected, yet they would have gone on and will go on inventing all the same; that there has been in some way a marvelous birth in this country of inventive capacity, and that it must grow whether it is protected or not.

Mr. President, it is not true. The inventor is no more a philanthropist than is the agriculturist. He works for his support. He works to achieve a competency. He invents, if you please, to become rich; but he is no more a philanthropist than any other man in any other walk or vocation of life, and you have no right to demand of him that he shall be a mere philanthropist. He is entitled to his reward. He is a laborer entitled to his hire, entitled to it more, if possible, than any other laborer, as his labor is higher in dignity and grandeur than that of any other laborer. I wish on this point to call attention to the testimony of Sir Henry Bessemer, as I find it on page 103 of a work called "Creators of the Age of Steel." I ask the Secretary to read it.

The Chief Clerk read as follows:

"The year 1866 may be said to mark a turning point in the inventive work of Sir Henry Bessemer. In each of the previous thirty years he had designed at least one invention, and in some years as many as ten; 1866 was the first year since 1838 in which no new patent was taken out by him. His greatest invention, the Bessemer process, was now bringing him in an income of £100,000 a year, and when 1866 showed a blank in his record of inventions, it might reasonably be assumed that henceforth he would rest from his labors. But next year his name again appeared in the list of new patentees, and he continued to take out patents for new inventions without interruption for the next ten years. Yet the period of his greatest activity was the eventful years which he devoted to perfecting his process of steel making. Having satisfied himself that the principle of that process was sound and practicable, he took out a fresh patent for each new improvement or substantial alteration, in order to secure his rights intact. Thus he took out fourteen patents in 1855, ten in 1856, and six in 1857, making thirty patents within three years, not to mention his numerous foreign ones."

Mr. Platt: The universal testimony of all inventors is that it is the reward which they hope to secure which stimulates their efforts. Is it so that an inventor of all the men in the world has no right to his reward? Is it so that he has no right to be protected in his property? It is the security to an inventor of his invention which makes it valuable and which stimulates him in his effort to make new inventions.

I have heard it argued that we had approached the perfection of the patent system, that there were no new worlds to conquer, that nature had no more secrets to bestow upon mankind for their benefit. So far from this being the case, we stand but in the very vestibule of the great storehouse of nature's secrets. We have but gathered a few pebbles along the shore on which beats a limitless sea. There is no limit to the evolution of human invention until it reaches the realm of the infinite. It requires no prophet's vision to see the coming glory and the coming triumph of the inventive skill of man.

Take but an instance or two of what is outlined on the horizon of the near future—the transmission and adaptation of electrical force, the combustion of water or its constituent elements, the application of compressed air. The whole inventive world is stirred to-day, stimulated, to find some new motive power. I saw in this city within a day or two a six horse-power engine which had been running for a month ten hours a day, driving the machinery in a machine shop, the only agent for the driving of which was a little jet of illuminating gas scarcely larger than that which we burn in a single burner, introduced into a cylinder in connection with common air. It has been run here in the city of Washington, where gas is $1.75 a thousand feet, at a very much less cost than the cost of a steam engine of equal power; and I am told that in one of the cities of Massachusetts more than five hundred of these gas engines are in operation, where the gas is supplied at about 50 cents per thousand feet. I am not certain about the fact, but I am so informed. Certain it is that cheaper motors are to be discovered; certain it is that we have not begun to discover the secrets of electrical force. We live in wonder-land. The miracle yesterday is the commonplace of to-day. The dream of the present is to be the fact of the immediate future.

No, Mr. President, every round of the ladder on which we have climbed to national pre-eminence is a patented invention, and every signboard which points to a greater future of achievement and progress shows that the path continues to lead through the field of invention. We are nearing the end of the contest to which our fathers invited us when they gave to our Government the power to promote the progress of science and the useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries. That contest was for the supremacy of the world, and the prize is now in full view. Shall we forget, shall we neglect the system which has enabled us to outstrip our competitors in the race, or shall we the rather perfect and develop it, that through its perfection and development we may attain still grander results? We stand to-day in the gateway of a most marvelous future. Let us hope that eyes may be given us to see that the inscription over the gate reads, "Protection to the American patent system and all that it comprehends and involves."

Mr. President, I leave this branch of my subject. I have but suggested where I would have desired to elaborate. It is as fascinating as an Oriental romance, a fairy tale, and the temptation to enlarge is very great, but there are some more practical considerations which I must present in support of this bill.

I say that the Patent Office should be made an independent Department, not only because of the vast importance of the interests which it must care for, but because of the treatment which it has received and must continue to receive so long as it remains a subordinate branch of the Interior Department.

In the first place, the Interior Department is overburdened; it is overloaded. No one man can discharge its duties properly. Let us see what the Secretary of the Interior has to do. He is charged with the supervision of the public business relating to patents for inventions; pension and bounty lands; public lands, including mines; the Indians; education; railroads; the public surveys; the census when directed by law; the custody and distribution of public documents; supervision of eleemosynary and literary institutions in the District of Columbia. He also exercises certain powers and duties in relation to the Territories.

Now take just three branches of the Interior Department—take the public lands; the railroads and their relations to the public lands; take the Indian Department—and tell me whether any one man can fairly discharge the duties which pertain to those three branches of his Department. Think of the multiplicity of important cases which must come to him for his personal decision. Think of the vast property interests which are to be decided in the mineral cases, the land cases, the railroad cases, which should receive his personal attention. In addition to all other duties he has the appointment and supervision of over 3,300 persons, and the executive administration of a Department which employs more than 3,300 agents.

If the Secretary of the Interior had as many heads as the Hindoo divinity Siva, and as many arms as Briareus, he could not personally perform all the duties pertaining to his office that would be most acceptably performed if he could give them personal attention.

Second, the duties which must be performed by the Secretary of the Interior in other branches of the Department always have led, and probably always will lead, to the selection for its head of a man who has no special adaptation for the important work of the Patent Office. Public opinion demands that the Secretary of the Interior must have defined ideas relating to the Indian policy; that he must have a knowledge of the laws relating to public lands; that he must understand the operation of the railroads in their relation to the Government; that he must have a Territorial knowledge which will enable him to administer so far as his duty requires the affairs of the Territories. He must have been trained in a different school from the man who should be selected for Commissioner of Patents or for the head of the Patent Department. Let me illustrate:

If the Secretary of the Interior is to be the superior officer, he must pass on questions of administration which he cannot so well understand as the Commissioner. Under the practice of the office he passes on most complicated questions affecting the right to inventions. There has been no Secretary of the Interior within my knowledge who has had any special adaptation to that office, who has been selected at all with reference to his mechanical judgment or mechanical skill, or because of his understanding of the complicated questions of patent law.

Now, what is the practice of the office? Here is the Commissioner. Under him is a force of examiners in chief, with twenty-four principal examiners and four assistants to each principal. Now there comes an application for a patent involving some question of mechanical principle, involving nice questions of priority of invention, of utility, of practice under the patent law. The application goes first to the principal examiner. He is supposed to be a man skilled in the arts, who has a thorough knowledge, special knowledge, technical knowledge of the division of the Patent Office which he oversees. He passes upon it. If rejected an appeal is taken to the examiners in chief, three men who are selected, or ought to be, for their extensive knowledge and experience in patent matters, who have a universal knowledge, so to speak, of inventions and of mechanical principles. If rejected there, an appeal may be taken to the Commissioner, and by the practice of the office an appeal may be taken from the Commissioner to the Secretary of the Interior.

Tell me if a Secretary of the Interior, selected because he has some idea of the political administration of the Government, because he has knowledge relating to the Indian tribes, because he has knowledge of the land laws of the United States, is the person to pass upon that patent question and to reverse the action of the Commissioner, based upon the action of the chief examiners and the principal examiner; and yet it is done in practice frequently.

I say, without any disrespect to any Secretary of the Interior, past or present, that he cannot be so well qualified to decide important questions involving mechanical principles and patent law as the subordinates whose decisions he must review. If it were so that the Secretary could personally decide all appeals from the decision of the Commissioner there would be less inconsistency in the situation, but I think it will be found that many appeals from the well considered action of the Commissioner are reviewed and practically decided by a clerk in the office of the Secretary of the Interior, who is known as the "patent and miscellaneous clerk."

There should be but one head. The office is double headed now. I wish I had time to refer fully to the law to show to what extent there is a double administration of the Patent Office. One or two references must suffice. Under the law the principal examiners, assistant examiners, heads of divisions, clerks, and all employes are appointed by the Secretary of the Interior upon the nomination of the Commissioner. The power of appointment, except as controlled by civil service rules, should be in the head of the Patent Office alone. He now may nominate. He is the best judge of the special qualifications required in the appointee, but he can only nominate. How little this power of nomination may influence nominations can be easily imagined. I once heard a Commissioner of Patents say that during his whole term, and it was not a very short one, not a single appointment was made in the Patent Office that he desired. He nominated men whom he thought best to fill the position with, but was in every instance given to understand that the nomination of some one of whom he knew nothing about would be agreeable to the Secretary. I ought in justice to say that this statement has no reference to the present Secretary.

The rules and regulations for the conduct of proceedings in the Patent Office are to be approved by the Secretary, and the Secretary is not unfrequently asked to overrule the action of the Commissioner in respect both to the making and application of rules. The Secretary of the Interior may overrule the Commissioner if he refuses for any cause to recognize an attorney or solicitor. Notwithstanding the office is self-supporting, all disbursements must be made by the disbursing clerk of the Secretary. The Commissioner cannot order the purchase of a board to be used in reproducing a model called for in the trial of a cause without the approbation of this clerk. It needs no argument to prove that both the efficiency and independence of the Commissioner must be impaired by this complexity of administration.

What should be the qualification of the head of the Patent Office? He should combine an accurate and almost universal knowledge of mechanical principles with a thorough knowledge of patent law and with rare executive and administrative ability. He should be pre eminently distinguished for these qualities. His position should be one of entire independence. It is more judicial than executive. His duties are more like those of a judge of a court than an executive officer; they are purely judicial and ministerial. The office should be permanent and it should be non-political, by which I mean it should have no political significance.

One of the great defects of the Patent Office has been that the Commissioner of Patents has felt, if not that he was in a position of degradation, he was not in a position of independence. He has felt that he has been overruled—to use perhaps not a very elegant phrase, snubbed—in the administration of his work. I do not speak of the present Commissioner or of the present Secretary of the Interior. I speak of my knowledge of the administration of the office in past years. So we have had Commissioners who have only been there for two or three years. The moment that they became adapted to discharge well the duties of their office they left and went into more lucrative occupation, and used the knowledge which they had acquired to obtain practice as patent attorneys or solicitors. It has been understood throughout the country that the office of Commissioner of Patents was accepted with its present salary and with the limitations upon it simply as offering a stepping stone to lucrative practice outside of the office after the Commissioner should resign.

The Commissioner should have salary enough to make him feel that he was occupying an office both of dignity and profit, and the salary and dignity should be at least equal to that of a circuit judge.

Every year's experience adds greatly to the capacity and ability of the Commissioner of Patents. In a word, the Patent Office needs and demands better administration, and it never will have it as a rule until it shall be made a separate Department. It must be held in entirely different estimation by Congress and by public sentiment before it will be what it ought to be. The way to secure this estimation by Congress, the way to secure for it what it wants and what it needs and what it must have if it is properly to discharge the high functions which devolve upon it, is to separate it entirely from any supervision by the Secretary of the Interior, to make it independent and dignified.

Third. It has been sadly neglected in the past. It must be enlarged and made more efficient, and this never will be as long as it remains simply a fifth wheel of the Interior Department coach.

Now, I wish to say a few words as to the ways in which its efficiency can be promoted. And I urge with emphasis that it must have more force and more room. I quote now from Mr. Burke's report as far back as 1848:

"Thus have I, in five separate communications to Congress and its appropriate committees within the last two years, made full expositions of the embarrassed condition of this office growing out of its greatly increased and increasing business, and the inadequacy of its force to perform its duties.

"In view of these facts, I am confident that the Patent Office cannot be held responsible for the embarrassments and delays which exist in one of the branches of its service. I am conscious that the inventors by whose contributions this important institution is sustained have grievous cause of complaint on account of the disappointments and injuries which they suffer from the delays which their business is compelled to encounter in the Patent Office, but I am confident their enlightened liberality will appreciate the earnest and persevering efforts which have been made by the undersigned to remove the just causes of their complaints, and that they will patiently wait the action of Congress for their relief, which, it is gratifying to know, may be confidently anticipated before the close of the present session."

Here is a quotation from the report of the Commissioner of Patents in 1872:

"The question of room for the Patent Office is becoming more and more serious every day. At the present time the working force is greatly crowded, and we are compelled to occupy rooms under ground, and with necessarily very imperfect ventilation. The health of many employes has been very seriously impaired and the work of the office greatly impeded. Since I have been in the office, now less than two years, eight persons have died, whose deaths were attributable, probably, to the occupancy of rooms unfit for such purposes. The files and the documents of the office are crowded into such small and inconvenient spaces as to be very difficult of access and very damaging to the files themselves. When additional rooms can be furnished for the working force of the office, those now unsuitable for occupancy by employes can be fitted for receiving the office files. I earnestly hope that some provision may be made whereby the work of the bureau may have sufficient room to be promptly and properly executed."

Let me call attention to what the present Commissioner said in his report last January:

"I cannot refrain from repeating what Mr. Commissioner Marble said in regard to the rooms occupied by the bureau. They are inadequate. I am compelled to keep valuable documents and records piled on the floor; some are in rooms so damp that the papers are mouldy.

"Many of the employes occupy small, dark, and damp rooms, and in numerous cases their health has been seriously impaired. Within a few years the entire building now occupied by the Department of the Interior will be required by this office for the proper accommodation of its force and the safe-keeping of its records and files."

I have a statement made this year by the Commissioner of Patents to the Committee on Appropriations, which I ask the Chief Clerk to read.

The Chief Clerk read as follows:

"Pending consideration of the legislative, executive, and judicial appropriation bill by Congress, the urgent needs of the Patent Office are herewith respectfully presented to the Committee on Appropriations.

"There has been a remarkable increase of inventive activity during the last few years, which brings a corresponding increase of work to the Patent Office, and makes the labor more arduous.

"Owing to the progress of the country, the great increase in population and wealth, the widespread rise and growth of new industries, more weighty interests, both of inventor and of manufacturer, are now at stake, and these are in a great measure dependent upon the thoroughness and accuracy of the work of the Patent Office.

"In pursuing their labors the examining corps of the Patent Office must not only compare pending applications with each other, adjudicating between them where they conflict, but they must compare each application for a patent, for a design patent, or for the registration of a trade mark or label, with patents and publications that have gone before, and apply all the tests of patentability established by law and by decisions founded in a long course of experience, the doctrines of combination, of aggregation, of mechanical skill, double use, new application, etc., as to the relations which these bear individually or in the aggregate upon the application or case under consideration.

"Knowledge, judgment, skill, experience, and industry are indispensable requisites.

"But with all human knowledge, with all human judgment, skill, and experience, with all human industry and perseverance, human capacity is limited.

"The increase in the field to be explored causes more than a direct ratio of increase in the labor to be performed. The increase rather resembles the rule of geometrical progression.

"The yearly number of applications now to be examined, including caveats, trade marks, and labels, is more than 39,000, nearly 40,000; and with amendments, arguments, appeals, interferences, and the various interlocutory questions raised by the able lawyers who have engaged in patent practice as a specialty, the labor and correspondence in the course of the examination of the applications for patents, etc., is immense.

"In 1848, when the grade of examiner was established, the total number of American patents was not over 6,000, and of English patents only about 12,000. These with such publications as were accessible at that time, there being only one alcove of books, about 1,000 volumes in the scientific library, constituted substantially the whole field over which search had to be made for anticipation of any alleged new device.

"At the present day the number of American patents is nearly 300,000, and that of the English patents over 140,000.

"As late as 1879 the number of English patents was only about 110,000.

"The number of French patents published was only about 100,000.

"The number of German patents was only 4,390.

"The number of Belgian patents was about 47,000.

"The number of books in the scientific library for consultation, including periodicals, etc., was not more than 29,000.

"Now let this be compared with the present field:

"As already said, the number of American patents alone is now nearly 300,000, and the increase per year is at the rate of about 21,000.

"The number of English patents at the end of 1883 was 140,047, and the increase is about 6,000 a year.

"The number of French patents published up to December 31, 1883, was about 172,000. The increase is about 6,000 a year.

"The number of German patents at the end of 1883 was 26,084. The increase is about 5,000 a year.

"The number of Belgian patents up to the end of 1883 was 60,043. The increase is about 3,500 a year.

"The number of Italian patents up to April 30, 1882, was about 13,500. The increase is about 1,250 a year.

"In addition there are thousands of Canadian, Austrian, New Zealand, Norwegian, and Spanish patents, together with patents of some other countries to be consulted; while the total number of volumes in the library up to December 31, 1883, was 41,322.

"A moment's consideration of these figures, and of the nature of a thorough examination into the legal and patentable novelty, will suffice to show the enormous growth in the labor of examination within the past few years and its constant increase, and would of itself indicate the absolute necessity for an increase in the force of the Patent Office.

"But to make this perhaps the more apparent, the following tables are presented to serve as a graphic illustration.

"These tables will give some idea of the work to be done, but they do not show the same fully, for they do not give the thousands of caveats (2,741 in 1883), the thousands of trade marks and labels (1,849 in 1883) to be examined, nor the appeals, the various motions, and the interferences which have to be considered and decided; nor can they indicate the immensely increased field of labor. The field of the past compared with that of the present is like a mere garden plat compared with the vast wheat fields of Dakota.

A.—*Table showing the average number of applications filed with each principal examiner.*

Year.	Principal examiners.*	Applications.	Average.
1848	4	1,628	407
1859	12	6,225	518+
1877	22	20,308	923+
1883	25	34,576	1,383+

* Exclusive of examiner of interferences.

B.—*Table showing the average number of applications filed to each individual of the examining force.*

Year.	Individuals.*	Applications.	Average.
1848	8	1,628	203+
1859	31	6,225	200+
1877	88	20,308	231+
1883	127	34,576	272+

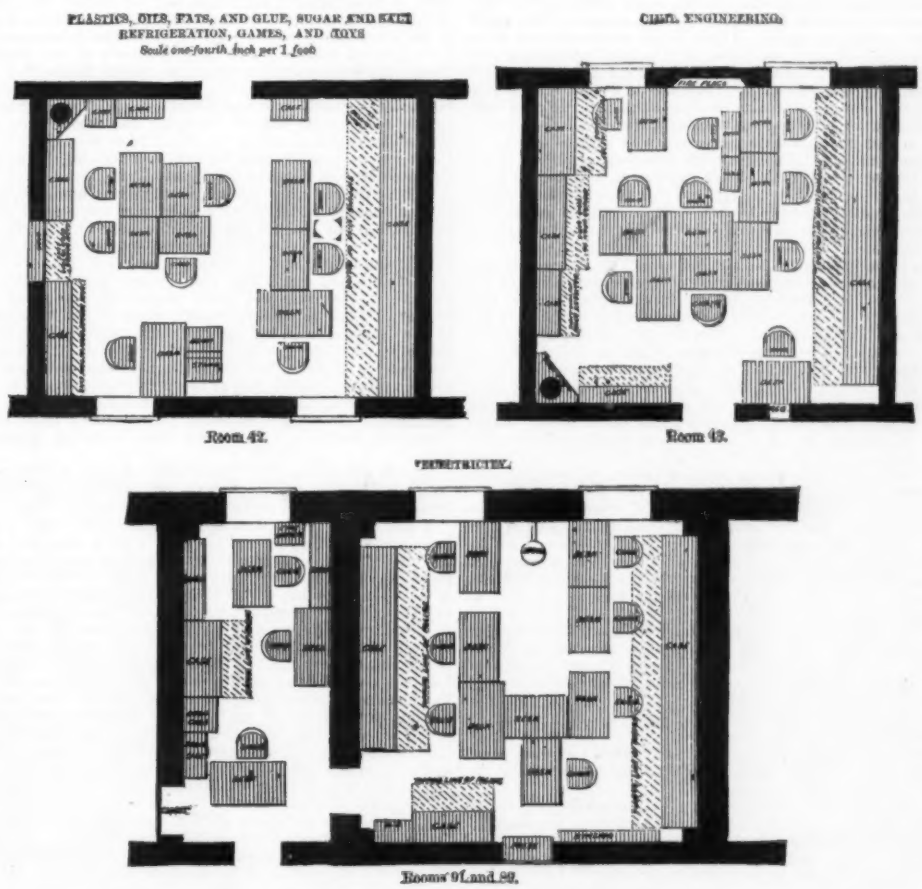
* Exclusive of assistant to examiner of interferences.

"Reports from the examiners show the work of the examining corps in the various divisions to be from two to eight months behind (that is, in some divisions of invention an application for a patent cannot be taken up for consideration in less than eight months from the time it is received in the division), and this notwithstanding the fact that the examining corps as a rule is composed of capable, energetic, and industrious men, who work many hours beyond the time prescribed.

"To assist the examining corps large draughts have had to be made upon other divisions of the office, and the consequence is that these divisions are likewise behind in their work.

"To bring the work of the Patent Office up and keep it so for the present there should be added to the present force four principal examiners, six first assistants, ten second assistants, fifteen third assistants, twenty-five fourth assistants, all males; in all sixty individuals."

Mr. Platt: The quotations which I have made from former Commissioners and the letter of the present Commissioners are but the echo of the plea of every Commissioner of Patents from the commencement of the office down to the present time. The universal cry has been for more room, for more force, for room and force to enable the office to keep up with its constantly increasing business. It has been more than a cry, it has been a wail. The office is shamefully and almost criminally limited and cramped for room. There are 1,000 employes in the Patent Office building, 471 of whom only belong to the Patent Office. The area occupied by the Patent Office for clerical purposes aggregates 22,113 square feet, or 53 square feet to each employe, excluding messengers, laborers, etc. No allowance has been made for passageways and space required for going from one part of the room to another part of the same room That is a little more than 7 feet square; it is 6 by 9. I have here a diagram of four of the rooms of the Patent Office, and by no means the worst crowded rooms, showing how they are occupied. I hope that the process of photolithography will enable it to be produced in time to go into my speech tomorrow. Senators can examine it at their leisure. [For diagram see below.]



Scale one-fourth inch per 1 foot.

I undertake to say that if there were tenement houses in the city of Washington crowded as the rooms in the Patent Office are crowded there would be one universal cry of indignation going up not only from the press of this city, but the press of the whole country. Yet in the Patent Office it goes on and nobody objects The space which is allotted to the clerical employes of the Patent Office may be large enough for a dungeon, it may be large enough for a tomb, and it may be a little too large for a grave, but it is not a fit amount of room for a human being to live and do the work of this Government in.

I wish to read a few words from the report of the Senator from Alabama (Mr. Morgan) from the Committee on Public Lands, of April 3, 1882, to the Senate. The committee was called upon to investigate the Land Office and see whether the clerks there had room enough. The Land Office is in the same building. The report says:

"From these statements a full understanding of the actual condition of the General Land Office and of the Interior Department building can be obtained. The committee agree that the Interior Department edifice is incapable of properly accommodating the Patent Office, the Bureau of Indian Affairs, and the General Land Office, and that these difficulties and embarrassments are increasing rapidly.

"The want of sufficient room, light, and ventilation is very damaging to the health of the employes and greatly delays them in their work, causing a serious loss of time and efficiency in their service. It also exposes the most valuable papers and records to theft and to great danger from fire, and has already caused the destruction of many of them by mould and decay, and by the ravages of insects and vermin."

Mr. Lockwood, the chief clerk, says:

"Aside from the question of injury to the service by a separation of the force and records, is the question of the health of the employes, who are so close together that it is frequently impossible to work to advantage. In the accounting division of the Indian Bureau, for instance, there are eight or ten people all crowded together in one room, and there is necessarily so much going on in the nature of conversations and passing to and fro that the public business is seriously interfered with. Some of the employes of the Land Office are occupying part of the model halls of the Patent Office, a place never intended to be used for such purposes. The necessity, however, of the accommodation of this force was upon us, and we had to do it. I consider it bad policy to have the records of any office located in the hallways, for various reasons. In the first place, they are damaged to a great extent by rats and other vermin. In many cases the original records and files of the Patent Office have been almost wholly destroyed, and cannot be replaced. There are numerous other reasons which will occur to the committee why there should be room for people to perform their duties, and for the proper care of the records. I have made a computation of the number of square feet occupied by each employe of the Department in the Land, Patent, and Indian Offices, and the highest number, I think, was about 8, and the lowest about 5, square feet."

I suppose it is a misprint for 5 feet square.

I have visited the Patent Office, and I undertake to say that if any Senator will go there and see where the clerks are performing their duties, will see where the most skilled experts of this country, with the best scientific attainments, are performing their duties down in the rooms which, until it became absolutely necessary to have more space, were used only for coal cellars, huddled together where the sunlight rarely or never shines in the room, where there is little or no ventilation, and where the air is so foul that I venture to say no Senator can stay an hour without becoming nauseated and sick, I think he would have little doubt that something should be done not only to increase the efficiency of the office but to prevent the almost barbarous treatment of its employes. I speak strongly, but I think no more so than the occasion demands. Yet notwithstanding all this cry for more room and more force, since this report was made in 1882, showing that there could be no more persons crowded into that building, the force of the Land Office has been increased thirty, the force in the Indian Office three, and to make room for them the force in the Patent Office has been decreased twenty-one.

As a matter of course the Patent Office is sadly behind in its work. In the division of chemistry they are eleven weeks behind; in textiles, seven months; in dairy, fences, tobacco, etc., five months; in hydraulics and pneumatics, four and a half months; in harvesters, eight and a half months. If a man produces an invention which will save one-half the cost, or one-quarter the cost, or one-tenth the cost of harvesting the entire crop of the West, he cannot get his application considered under eight months in the Patent Office, by reason of the want of force. In fine arts, apparel, etc, the office is four months behind; in printing, binding, and paper manufacture, seven and a half months; in civil engineering, three and a half months; in household furniture, five months; in heating, illuminating, and drying, four and a half months; in electricity, three months; in metal work, three and a half months. These are a few of the divisions of the office. Others are not so far behind, but scarcely any of them are able to keep up with current applications.

Whenever more clerical force has been applied for, the answer which I have heard has been, first, want of room, and second, economy. There never will be room enough until it is made a separate department. These other branches and divisions of the Interior Department will crowd upon it and crowd it down, as they have done in the past. As for economy, I have shown that the Patent Office has been and is still a supplicant. It begs for what it should have as a right, and then it seldom gets what it begs for. I have shown that it has been crowded into the coal holes and the basement, where foul gases and impure odors destroy health, and where work must be inadequately performed.

Would you think that this "pauper whom nobody owns"

is the only self-sustaining branch of this Government, the only branch of bureau of the Government that pays its way? It has paid all its expenses and has a fund to its credit to-day of $2,727,107, not including, as I believe, the amount that Congress took from its fund to help pay for the building into the basement and coal cellars of which it has been largely crowded. That would swell its surplus to over $3,000,000.

I said it had a surplus fund. I should have said it did have a surplus fund once; it controlled the surplus fund once; but in such poor estimation was it held that its fund was taken away from it by public law, and to-day and for years past it has had to pay day by day its earnings into the Treasury of the United States, the surplus to be used for the benefit of the other departments of the Government. Surplus no longer exists in practice; and nevertheless let me say the inventors of this country feel as if that Patent Office building belonged to them. They built it. It was built for them. They have more than paid for it. They can pay for it to-day out of the surplus fund of the Patent Office and still have a surplus. More than $1,500,000 has been paid into the Treasury by inventors on rejected applications alone.

I undertake to say that visitors who come here from foreign lands and from distant parts of our own country have no idea but what that building is exclusively used, or nearly so, by the Patent Office. They have no idea that there are over five hundred other clerks within the building, and that its poorest part is assigned to the Patent Office. The truth is, the Patent Office has been crowded into the kitchen of the house it built, it has been made to eat with the servants, and the other bureaus of the Department sit in the parlors and regale themselves with the delicacies of the family table.

The system of examination should be greatly improved. The value of the patent system depends largely upon a more thorough examination of the applications. The statement of the Commissioner, read by the chief clerk, shows how impossible it is to make any careful examination of the applications which are made. I have heard within the last week of the case of an application for a patent involving a new process; if it be patentable, a process which will largely revolutionize certain branches of business in the country, a process about the patentability of which the inventor had serious doubt, his attorney had serious doubt. All the examination that that application received was such as was given to it when it was referred by the principal examiner in the morning to one of the assistant examiners, and before noon was passed upon affirmatively, and the order to issue a patent made. Such hurried, incomplete examinations are simply unavoidable. The examiners cannot give the time to the examination of applications which care requires.

As I said, the future utility and benefit of the patent system depends largely upon a more rigid examination of applications. It is the duty of the Patent Office to see that patents are not improperly issued as well as to see that patents are properly issued. It is the duty of the Patent Office to so examine the applications as that no title deed to an invention will be given to an applicant if he is not actually and truly the first and original inventor of a useful improvement; and I venture to say this never will be done until the Patent Office is made an independent department. I venture to say that so long as it obtains its supplies, its moneys, through the grace of the Secretary of the Interior, it never will have sufficient force to examine patents properly or have sufficient room for the examiners to work in.

What is the result of a want of careful examination? The result is, first, that the public is imposed upon. In the second place, that patentees have to become litigants to determine their rights. This is a matter which has been frequently urged by Commissioners, and I ask especially to refer to the Report of Commissioner Leggett, in 1873, at page 9:

"It is well known that complaints from many sections of the country against our whole patent system arise almost exclusively from patents that are improperly granted, because of the want of proper supervision in their examination; and with so many persons examining and passing applications for issue, it is an impossibility to establish anything like a uniformity of practice in the office or to get any such supervision as will attain what the law is intended to secure—that is, the rights of the inventor without infringing upon the rights of the public."

I also call attention to the present Commissioner's report with reference to the increase of the salaries of the examining force, an absolute necessity if the services of men having the knowledge capacity required to discriminate in the granting of patents are to be retained:

"I concur in what my predecessor said in his report, dated September 14, 1883, to the honorable the Secretary of the Interior, in regard to salaries. The examining corps in this bureau should be composed of men of first class ability and undoubted integrity. It is of consequence to inventors and to the people at large that patents should not be improvidently issued. The examining corps must, in the main, be relied upon to prevent this. Not one patent in fifty comes under the personal supervision of the Commissioner or his assistant. The examiners determine these important questions in the first instance, and in a great majority of cases, first and finally. The Government, I submit, can afford (especially when inventors provide the funds) to pay as full compensation for first class ability and strict integrity as a private individual or corporation. The experience of the office is that it is next to impossible to secure, with the hope of retaining for more than a short period, assistant examiners whose thorough fitness renders them especially valuable to the service. They are constantly leaving to accept more lucrative employment outside. Since every conceivable advantage is on the side of just, not to say liberal, compensation, I trust it may please Congress to adopt the suggestions of my predecessor and provide the increase of salaries indicated in the estimates submitted, as well as for the increase of the force employed."

Under the present system of inadequate salaries the examiners, finding that they can earn much more outside of the office than in it, that they can at least earn as much where their lives and health will be less endangered, frequently, I may say usually, resign just when the knowledge acquired in the office makes their retention especially desirable. A fair increase in the salary of examiners, with proper rooms in which to discharge their duties, would, I believe, result in giving the office the benefit of the life services of a body of the most skilled and scientific experts in the world, and vastly enhance the value of our patent system.

If the creation of an independent department for the Patent Office has only the effect to discriminate in the granting of patents and the adequate compensation of the examining corps, the benefit conferred upon the country will be immense.

I wish to say that there should be a classification and abridgment of patents. This was proposed in 1873, and from 1873 to 1880 the Commissioners called repeatedly attention to it. In 1880 at last an appropriation of $10,000 was grudgingly given—no, let me say was wrung from Congress—for the classification and abridgment of patents. What do we want this classification and abridgment of patents for? Simply that all the patents may be brought together and arranged under their respective heads, as, for instance, the patents relating to agriculture, and that they may be abridged so that not only the inventors, but the person who is to buy or use a patented invention, can have the volume before him and see whether he is about to trespass upon or infringe the right of some other inventor. In short, the inventor wants such an abridgment that he may see whether the contrivance he is thinking about has already been patented. The public wants it to secure itself against imposition. I am quite convinced that such an abridgment, accessible to all, would greatly reduce the number of applications for unpatentable devices, and largely prevent the sale of worthless or anticipated patents.

Now, is not that a good work? Is it not a work that needs to be done? Yet when $10,000 had been wrung from a reluctant—I will not say hostile—Congress in 1880 to pursue this work, and when they got the classification and abridgments nearly done as to agricultural patents, the work was stopped, because the appropriation was stopped. The Patent Office was paying $300,000 a year over its expenses into the United States Treasury, but they could not have $10,000 a year to continue this necessary and beneficial work that would undoubtedly pay its own expenses; and the first volume, though nearly completed, has never been issued, and is so much dead and useless material in the Patent Office storage rooms.

So, too, the printing of specifications of old patents should be continued. By that I mean this: The specifications of patents have all been printed back to about No. 47,000. The work should be completed back to the first patent. There ought to be a complete printed record of all the patents of the United States from the first granted down to the present time. Such reproduction would be useful not only to inventors but to every citizen. It is a part of the history of our progress; so the index of patentees should be completed. Let me read, at the risk of wearying the Senate that has been so indulgent to me, a few words from the report to the Commissioner of Patents by the chief of the Issue and Gazette division, January 18, 1884:

"Some twelve years ago an attempt was made to complete a general index which should not only cover these patents, but all patents down to the date of compilation (1873). The subject-matter portion was completed, published, and bound in three volumes, and has since been on sale at $10 per set. The companion volume, Index to Patentees, covering the same period of time, was not finished, and came into my hands, when I assumed charge of the division, in an incomplete state, awaiting an appropriation. As opportunity offered, with only the regular force of the division, the preparation of the work for the printer was completed, but as no appropriation could be obtained for its publication, the matter has lain in manuscript packages in the storage rooms of the basement until dust, dampness, handling, and the rats have seriously damaged it."

That is a fine showing for an office in this Government which is not only paying its way, but paying at the rate of from $300,000 to $500,000 a year into the national Treasury.

While I have been speaking I have received from a prominent manufacturing firm in my own State a dispatch, asking me if I cannot say something in favor of reducing patent fees. Mr. President, the patent fees ought to be reduced. A tax upon inventors which produces more than enough to pay the current expenses of the office is simply shameful. It is a tax upon knowledge, a tax on invention, a tax which in itself is as iniquitous and abominable as a tax upon authors or scientists would be. Still I am compelled to say that I do not want the fees paid by inventors reduced until the Patent Office becomes a separate Department. I want this glaring inconsistency of the inventors of the country paying the expenses of that branch of the Government, and furnishing the Government from $300,000 to $500,000 annually in addition, to continue until its voice shall be heard through the land in favor of the establishment of the Patent Office as an independent department.

Agriculturists have been slow to acknowledge their dependence on patents, but they have been loud in their demands for the enlargement of the Agricultural Department. What was the origin of the Agricultural Department? It is the child of the Patent Office. The Patent Commissioner had charge of the agricultural work from 1836 to 1862, and if I am not mistaken the inventors of the country paid the entire expense of that service in connection with the Patent Office for twenty-five years. Until 1849 there was no separate report. The Commissioner of Patents reported his work in the agricultural line, and from 1849 up to 1862, when there was a separate report, it was called the Patent Office Report, and to-day men write me for the Agricultural Report and call it the Patent Office Report. Many of the farmers in this country still believe that the Agricultural Department is in some way connected with the Patent Office.

The Agricultural Department is the daughter of the Patent Office, but we have taken the daughter away from her mother; we have built her a fine house and furnished elegant surroundings; we have given her costly and fashionable clothing; we pet, I will not say pamper, her; we pay her every possible attention, while the old lady, her foster mother, still scrubs along in the kitchen of the Interior Department, and is never noticed except when she deposits the surplus of her daily earnings in the Treasury for the benefit of the rest of the family. It is a shame, and the inventors are beginning to regard it as a shame, and they are going to be heard in their demand that the Patent Office shall receive better treatment than it has received. I make no complaint that the Agricultural Department has been made independent; I only protest against the studied neglect of its parent.

Let me close by noticing an argument that I have heard urged aginst this bill. I have heard it stated that the moment we get the Patent Office created an independent department we shall be wanting to have its head a Cabinet officer. That demand will never come from me, Mr. President; and if I am here in my place in the Senate and it is ever made, I will oppose it. There is no reason why the head of the Patent Office department should be a member of the Cabinet. The Cabinet is large enough already. It requires neither the Commissioner of Agriculture nor the Commissioner of Patents within it. They cannot add to its value; they cannot add to its strength. The patent department is not of a character which requires representation in the executive council; it exercises little influence on the administrative policy of the Government, very little more influence than do the courts. There is neither need nor propriety that the head of the department should be one of the President's constitutional advisers, and I venture to say that in the last twenty years no question has ever arisen in Cabinet council regarding the administration of the business of the Patent Office. I venture to say the Secretary of the Interior has not been called upon in Cabinet sessions in twenty years to express any opinion as to the management of that portion of his Department. With the other branches it is different; the railroads, the Indians, and the lands have much to do with the political management of our Government. The administration must have a policy with regard to the Indians, with regard to land grants and land-grant railroads, but as to patents it needs and should have no other policy than that so plainly expressed in the Constitution.

Mr. President, I think I have given sound reasons why the patent system should be permitted to stand alone. If time would have permitted, I might have urged many other weighty considerations. I am sure that in what I have said I voice the sentiment of a great multitude of our people who have a right to be heard and who will be heard in favor of this proposition. It is a voice that comes from men who have contributed most to our national prosperity, to our power, to our influence, to our advancing civilization. It is rather a demand than a voice, and we shall do well to heed it.

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MR. W. E. DEBENHAM makes use of a kerosene lamp giving a flame of a fair degree of brilliance, and glazed with green glass of a class having a somewhat rough appearance and now being extensively employed in church and other windows, in which the colored glass of a former epoch is being imitated. This green pane is supplemented by two thicknesses of pale orange paper, and the light it gives is very agreeable to work by, and not detrimental to the sight. On this latter subject Mr. William Ackland, a clever, surgeon-oculist, of London, has said that the ruby light in general use in the dark room is proving exceedingly injurious to the eyes of photographers.

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